



# 13th Flatfish Biology Conference 2012 Program and Abstracts

December 4-5 2012  
Water's Edge Resort and Spa, Westbrook, CT

by Conference Steering Committee: Renee Mercaldo-Allen (Chair),  
Anthony Calabrese, Donald Danila, Mark Dixon, Elizabeth Fairchild,  
Ambrose Jearld, Thomas Munroe, Deborah Pacileo,  
Christopher Powell, and Sandra Sutherland

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by Conference Steering Committee: Renee Mercaldo-Allen (Chair)<sup>1</sup>,  
Anthony Calabrese<sup>1</sup>, Donald Danila<sup>2</sup>, Mark Dixon<sup>1</sup>, Elizabeth Fairchild<sup>7</sup>,  
Ambrose Jearld<sup>3</sup>, Thomas Munroe<sup>4</sup>, Deborah Pacileo<sup>5</sup>,  
Christopher Powell<sup>6</sup>, and Sandra Sutherland<sup>3</sup>

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# 13<sup>th</sup> Flatfish Biology Conference 2012

December 4<sup>th</sup> & 5<sup>th</sup>  
Water's Edge Resort and Spa, Westbrook, CT

## Oral Presentations Salons A/B

Tuesday, December 4<sup>th</sup>

**8:00 a.m.**      **Registration/Coffee/Continental Breakfast**

**8:45 a.m.**      Welcome and Introduction  
**Renee Mercaldo-Allen, Chair**  
*NOAA Fisheries, Northeast Fisheries Science Center  
Milford Laboratory, Milford, CT*

**Russell Brown, Deputy Science and Research Director**  
*NOAA Fisheries, Northeast Fisheries Science Center  
Woods Hole Laboratory, Woods Hole, MA*

### Session I

**Thomas Munroe, Chair**

*NOAA Fisheries, Northeast Fisheries Science Center  
National Systematics Laboratory, Smithsonian Institution  
Washington, DC*

**9:00 a.m.**      Evaluating Freshwater Residence Patterns in Southern Flounder  
From Subtropical Estuaries  
**Benjamin Walther and Megan Nims**  
*University of Texas, Marine Science Institute, Port Aransas, TX*

**9:20 a.m.**      Winter Flounder Larvae in Great Salt Pond and Old Harbor, Block Island,  
Rhode Island 2012  
**Grace Klein-MacPhee<sup>1</sup>, Eric G. Schneider<sup>1</sup>, Valerie A. Cappola<sup>2</sup>,  
and Grace Bowles<sup>2</sup>**  
*<sup>1</sup>Rhode Island Department of Environmental Management, Division of  
Fish and Wildlife, Marine Fisheries, Coastal Fisheries Laboratory,  
Jamestown, RI, <sup>2</sup>US Army Corps of Engineers, Concord, MA*

**9:40 a.m.** Historical Abundance of Juvenile Summer Flounder (*Paralichthys dentatus*) in Rhode Island Estuaries and Tidal Rivers  
**David L. Taylor and Danial G. Palance**  
*Roger Williams University, Department of Biology and Marine Biology, Bristol, RI*

**10:00 a.m.** Comparing Ages of Winter Flounder, *Pseudopleuronectes americanus*, Using Scales and Otoliths: Is Better Accuracy Really Worth Slowing Down Production Processing?  
**Grace Thornton and Eric Robillard**  
*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA*

**10:20 a.m. Break/Coffee/Refreshments**

## **Session II**

**Sandra Sutherland, Chair**

*NOAA Fisheries, Northeast Fisheries Science Center  
Woods Hole Laboratory, Woods Hole, MA*

**10:40 a.m.** Temporal Patterns of Flatfish Recruitment to the Moon River, Georgia  
**Austin W. Francis, Jr.**  
*Armstrong Atlantic State University, Department of Biology, Savannah, GA*

**11:00 a.m.** Recruitment Decline in Juvenile Benthic Marine Fish in the Norwalk and Saugatuck Estuaries from 1991 to the Present  
**Richard Harris<sup>1</sup>, Peter Fraboni<sup>1</sup>, Nikki Cantatore<sup>1</sup>, Joshua Cooper<sup>1</sup>, and Students<sup>2</sup>**  
*<sup>1</sup>Earthplace, Westport, CT, <sup>2</sup>Wilton High School, Wilton, CT*

**11:20 a.m.** Winter Flounder Populations in Two Estuaries on Martha's Vineyard, Massachusetts  
**Elizabeth A. Fairchild<sup>1</sup>, Nathan Rennels<sup>1</sup>, Warren Doty<sup>2</sup>, John Armstrong<sup>2</sup>, Shelley Edmundson<sup>1</sup>, Danielle Ewart<sup>3</sup>, David Grunden<sup>4</sup>, Bret Stearns<sup>5</sup>, Andrew Jacobs<sup>5</sup>, and Christopher W. D. Gurshin<sup>1,6</sup>**  
*<sup>1</sup>University of New Hampshire, Department of Biological Sciences, Durham, NH, <sup>2</sup>Dukes County/Martha's Vineyard Fishermen's Association, Chilmark, MA, <sup>3</sup>Shellfish Department, Tisbury, MA, <sup>4</sup>Shellfish Department, Oak Bluffs, MA, <sup>5</sup>Wampanoag Tribe of Aquinnah, Department of Natural Resources, Aquinnah, MA, <sup>6</sup>Normandeau Associates Inc., Portsmouth, NH*

**11:40 a.m.** Variation in Condition of Young-of-the-Year Summer Flounder from Virginia Estuaries  
**Ryan W. Schloesser and Mary C. Fabrizio**  
*Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA*

**12:00 p.m.** Laboratory Investigations of Winter Flounder Egg Interactions with Suspended and Bed Sediment  
**Jarrell Smith<sup>1</sup>, Elizabeth Fairchild<sup>2</sup>, Christopher Chambers<sup>3</sup>, Ehren Habeck<sup>3</sup>, Nathan Rennels<sup>2</sup>, and Douglas Clarke<sup>1</sup>**  
*<sup>1</sup>US Army Engineer Research and Development Center, Vicksburg, MS, <sup>2</sup>University of New Hampshire, Department of Biological Sciences, Durham, NH, <sup>3</sup>NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ*

**12:20 p.m.** Hosted Plated Lunch

### **Session III**

**Christopher Powell, Chair**

*Rhode Island Division of Environmental Management (retired)  
Division of Fish and Wildlife, Marine Fisheries, Jamestown, RI*

**1:20 p.m.** Can Variation in Fecundity of Winter Flounder (*Pseudopleuronectes americanus*) be Explained by Measures of Condition?  
**Mark J. Wuenschel, W. David McElroy, and Richard S. McBride**  
*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA*

**1:40 p.m.** Comparison of Fecundity and Down-Regulation among Stocks and Years for Female Yellowtail Flounder, *Limanda ferruginea*  
**David W. McElroy, Emilee K. Towle, Yvonna K. Press, Mark J. Wuenschel, and Richard S. McBride**  
*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA*

**2:00 p.m.** Biophysical Dynamics of Larval Summer Flounder Ingress Into Delaware Bay  
**Edward A. Hale<sup>1</sup>, Elizabeth W. North<sup>2</sup>, Wen Long<sup>2</sup>, and Timothy E. Targett<sup>1</sup>**  
*<sup>1</sup>University of Delaware, Lewes, DE, <sup>2</sup>University of Maryland Center for Environmental Science, Cambridge, MD*

- 2:20 p.m.** Inter-Female Differences in Offspring Quality in Summer Flounder, *Paralichthys dentatus*  
**R. Christopher Chambers<sup>1</sup>, Ehren A. Habeck<sup>1</sup>, and Dawn D. Davis<sup>2</sup>**  
<sup>1</sup>NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ, <sup>2</sup>Office of Coastal Protection and Restoration, Baton Rouge, LA
- 2:40 p.m.** Spatial Predictive Models of Summer Flounder (*Paralichthys dentatus*) Abundance in the New York Bight  
**Zach Singer-Leavitt**  
 New York Department of State, Division of Coastal Resources, Albany, NY
- 3:00 p.m.** Long-term Patterns of Abundance of Blackcheek Tonguefish, *Symphurus plagiatus* Linnaeus, (Pleuronectiformes: Cynoglossidae), in Lower Chesapeake Bay and its Major Tributaries  
**Troy D. Tuckey<sup>1</sup>, G. Hank Brooks<sup>1</sup>, and Thomas A. Munroe<sup>2</sup>**  
<sup>1</sup>Virginia Institute of Marine Science, The College of William and Mary, Department of Fisheries, Gloucester Point, VA, <sup>2</sup>NOAA Fisheries, Northeast Fisheries Science Center, National Systematics Laboratory, Smithsonian Institution, National Museum of Natural History, Washington, DC
- 3:20 p.m. Refreshment Break**

## Session IV

**Elizabeth Fairchild, Chair**

*University of New Hampshire, Department of Biological Sciences  
 Durham, NH*

- 3:40 p.m.** Characterization of Summer Flounder Nursery Areas in Virginia  
**Lauren Nys, Mary C. Fabrizio, and Troy Tuckey**  
*Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA*
- 4:00 p.m.** Winter Flounder Distribution in Southern New England- Insights from Industry-based Trawl Surveys  
**Greg DeCelles, Sally Roman, and Steve Cadrin**  
*University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST), Fairhaven, MA*
- 4:20 p.m.** Winter Flounder Habitat Use in New York/New Jersey Harbor and the Influence of Spring Temperatures on Subsequent Year Class Strength  
**Dara Wilber<sup>1</sup>, Catherine Alcoba<sup>2</sup>, Jenine Gallo<sup>2</sup>, and David Davis<sup>3</sup>**  
<sup>1</sup>Bowhead Science and Technology, Charleston, SC, <sup>2</sup>US Army Corps of Engineers, New York District, New York, NY, <sup>3</sup>Henningson, Durham, and Richardson Engineering Inc., Pearl River, NY

- 4:40 p.m.** Using Flatfish Research to Maintain K-12 Student Interest in Science  
**Mary Carla Curran<sup>1</sup>, Terry Aultman<sup>2</sup>, and Heidi Schaffner<sup>3</sup>**  
<sup>1</sup>*Savannah State University, Savannah, GA*, <sup>2</sup>*Savannah Christian Preparatory School, Savannah, GA*, <sup>3</sup>*Jacob G. Smith Elementary, Savannah, GA*
- 5:00 p.m.** The Influence of Tidal Cycle on the Feeding of Juvenile European Plaice, *Pleuronectes platessa* L., on a Small Nursery Ground (Port Erin Bay, Isle of Man) in the Irish Sea  
**Audrey J. Geffen<sup>1,2</sup> and Richard D. M. Nash<sup>1,3</sup>**  
<sup>1</sup>*Port Erin Marine Laboratory, Port Erin, Isle of Man, British Isles*,  
<sup>2</sup>*University of Bergen, Department of Biology, Bergen, Norway*, <sup>3</sup>*Institute of Marine Research, Bergen, Norway*
- 5:20 p.m.** Poster Set-up
- 5:30 p.m.** Hosted Mixer and Poster Session

### Wednesday December 5<sup>th</sup>

- 7:30 a.m.** Registration/Coffee/Continental Breakfast

#### Session V

#### Ambrose Jearld, Chair

*NOAA Fisheries, Northeast Fisheries Science Center  
Woods Hole Laboratory, Woods Hole, MA*

- 8:00 a.m.** The Caudal Neurosecretory System (CNSS): Function in Salinity Adaptation of the Euryhaline Flounder, *Platichthys flesus*  
**Weiqun Lu**  
*Shanghai Ocean University, College of Fisheries and Life Science, Shanghai, China*
- 8:20 a.m.** Testing of a Modified Groundgear to Reduce the Catch of Flatfish in the Large Mesh Groundfish Trawl Fishery  
**Sally Roman and Pingguo He**  
*University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST), Fairhaven, MA*
- 8:40 a.m.** Association of Estuarine Bivalve Shell Habitats to the Historic Winter Flounder, *Pseudopleuronectes americanus*, Fyke Net Fishery of Eastern Connecticut  
**Tim Visel**  
*The Sound School, New Haven, CT*

- 9:00 a.m.** The NOAA Ocean Acidification Plan: Designing an Experimental System to Test the Effects of Water Conditions Specific to Ocean Acidification on the Early Life Stages of Flatfish  
**Daniel Wieczorek, Jennifer Samson, Beth A. Phelan, R. Christopher Chambers, Mathew E. Poach, and DeMond Timmons**  
*NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ*
- 9:20 a.m.** The Effects of Ocean Acidification on the Early Life-Stages of Commercially Important Flatfish of the Northeast USA  
**R. Christopher Chambers<sup>1</sup>, Ehren A. Habeck<sup>1</sup>, Allison C. Candelmo<sup>1</sup>, Matthew E. Poach<sup>1</sup>, Daniel Wieczorek<sup>1</sup>, Beth, A. Phelan<sup>1</sup>, Elaine M. Caldarone<sup>2</sup>, and Keith R. Cooper<sup>3</sup>**  
<sup>1</sup>*NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ*, <sup>2</sup>*NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI*, <sup>3</sup>*Rutgers University, Department of Biochemistry and Microbiology, New Brunswick, NJ*
- 9:40 a.m.** An Initial Look at Developmental Success of Winter Flounder Ichthyoplankton in New York / New Jersey Harbor  
**Dara Wilber<sup>1</sup>, Laura Csoboth<sup>2</sup>, Ann Marie DiLorenzo<sup>3</sup>, Catherine Alcoba<sup>3</sup>, and Jenine Gallo<sup>3</sup>**  
<sup>1</sup>*Bowhead Information Technology Services, Charleston, SC*, <sup>2</sup>*Henningson, Durham, and Richardson Engineering, Inc., Pearl River, NY*, <sup>3</sup>*US Army Corps of Engineers, New York District, New York, NY*

**10:00 a.m. Break/Coffee/Refreshments**

**Session VI**

**Donald Danila, Chair**

*Dominion Nuclear Connecticut, Inc.  
 Millstone Environmental Laboratory (retired)  
 Waterford, CT*

*ASA Analysis & Communications, Inc.  
 East Lyme, CT*

- 10:20 a.m.** A First Step Toward Analyzing Morphometrics of Winter Flounder Ichthyoplankton in New York / New Jersey Harbor  
**Laura Csoboth<sup>1</sup>, David Davis<sup>1</sup>, Dara Wilber<sup>2</sup>, Ann Marie DiLorenzo<sup>3</sup>, Catherine Alcoba<sup>3</sup>, and Jenine Gallo<sup>3</sup>**  
<sup>1</sup>*Henningson, Durham, and Richardson Engineering, Inc., Pearl River, NY*, <sup>2</sup>*Bowhead Information Technology Services, Charleston, SC*, <sup>3</sup>*US Army Corps of Engineers, New York District, New York, NY*

- 10:40 a.m.** The Influence of Cage-conditioning on the Performance and Behavior of Japanese Flounder Reared for Stock Enhancement: Burying, Feeding, and Threat Response  
**Michelle L. Walsh<sup>1,2</sup>, Reiji Masuda<sup>2</sup>, and Yoh Yamashita<sup>2</sup>**  
<sup>1</sup>*University of New Hampshire, Department of Biological Sciences, Durham, NH,* <sup>2</sup>*Kyoto University, Graduate School of Agriculture, Maizuru Fisheries Research Station, Maizuru, Kyoto, Japan*
- 11:00 a.m.** Regional Spatial Dynamics of Yellowtail Flounder on the Northeast US Shelf  
**Megan P. O'Connor, David E. Richardson, and Jonathan A. Hare**  
*NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI*
- 11:20 a.m.** New Western Pacific Species of Bothid Flatfishes (*Lophonectes*: Pleuronectiformes: Bothidae)  
**Thomas A. Munroe**  
*NOAA Fisheries, Northeast Fisheries Science Center, National Systematics Laboratory, Smithsonian Institution, National Museum of Natural History, Washington, DC*
- 11:40 p.m.** Changes in Larval, Juvenile, and Adult Yellowtail Flounder Distributions and Habitat Use on the Northeast US Shelf Over the Last Four Decades  
**Harvey J. Walsh, David E. Richardson, Megan O'Connor, and Jonathan A. Hare**  
*NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI*
- 12:00 p.m.** Factors Determining Accessory Growth Centre Formation and Otolith Growth during the Development of Otolith Microstructure in European Plaice, *Pleuronectes platessa* L.  
**Audrey J. Geffen<sup>1,2</sup>, Helen Rossetti<sup>1</sup>, and Richard D. M. Nash<sup>1,3</sup>**  
<sup>1</sup>*Port Erin Marine Laboratory, Port Erin, Isle of Man, British Isles,* <sup>2</sup>*University of Bergen, Department of Biology, Bergen, Norway,* <sup>3</sup>*Institute of Marine Research, Bergen, Norway*
- 12:20 p.m.** **Hosted Buffet Lunch**

## Session VII

### Anthony Calabrese, Chair

*NOAA Fisheries, Northeast Fisheries Science Center (retired)  
Milford Laboratory, Milford, CT*

- 1:20 p.m.** Assessing the Decline of Winter Flounder on Long Island: An Overview of SoMAS Research  
**Lyndie A. Hice, Anne E. McElroy, Adrian P. Jordaan, and Michael G. Frisk**  
*Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY*
- 1:40 p.m.** Regional Differences in Mortality and Condition of Young-of-the-Year Winter Flounder in Long Island Bays  
**Lyndie A. Hice<sup>1</sup>, Anne E. McElroy<sup>1</sup>, Mark D. Fast<sup>1,2</sup>, and Michael G. Frisk<sup>1</sup>**  
*<sup>1</sup>Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY, <sup>2</sup>Atlantic Veterinary College, University of Prince Edward Island, Department of Pathology and Microbiology, Charlottetown, PEI, Canada*
- 2:00 p.m.** Extremely High Levels of Inbreeding in Winter Flounder from Southern Long Island Bays  
**Shannon J. O’Leary<sup>1</sup>, Lyndie A. Hice<sup>1</sup>, Kevin A. Feldheim<sup>2</sup>, Michael G. Frisk<sup>1</sup>, Anne E. McElroy<sup>1</sup>, Mark D. Fast<sup>1,3</sup>, and Demian D. Chapman<sup>1,4</sup>**  
*<sup>1</sup>Stony Brook University, School of Marine and Atmospheric Science, Stony Brook, NY, <sup>2</sup>Pritzker Laboratory for Molecular Systematics and Evolution, The Field Museum, Chicago, IL, <sup>3</sup>Atlantic Veterinary College, University of Prince Edward Island, Department of Pathology and Microbiology, Charlottetown, PEI, Canada, <sup>4</sup>Stony Brook University, Institute of Ocean Conservation Science, Stony Brook, NY*
- 2:20 p.m.** Transcriptional Profiling of Young-of-the-Year Winter Flounder in Long Island Bays  
**Anne E. McElroy<sup>1</sup>, Lyndie A. Hice<sup>1</sup>, Michael G. Frisk<sup>1</sup>, and Mark D. Fast<sup>1,2</sup>**  
*<sup>1</sup>Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY, <sup>2</sup>Atlantic Veterinary College, University of Prince Edward Island, Department of Pathology and Microbiology, Charlottetown, PEI, Canada*

**2:40 p.m.**      Alternative Overwintering Survival Strategy in Young-of-the-Year Winter Flounder

**Richard Bell and Jeremy Collie**

*University of Rhode Island, Graduate School of Oceanography,  
Narragansett, RI*

**3:00 p.m.**      **Adjourn Meeting**

## **Poster Session**

### **Salon C**

**Tuesday December 4<sup>th</sup>, 5:30 p.m.**

**Deborah Pacileo, Chair**

*Connecticut Department of Energy and Environmental Protection  
Marine Fisheries Division, Old Lyme, CT*

Characterizing Winter Flounder (*Pseudopleuronectes americanus*) Nursery Areas Using Otolith Microstructure and Microchemical Techniques

**David Bailey and Elizabeth A. Fairchild**

*University of New Hampshire, Department of Biological Sciences, Durham, NH*

Historical Spatial Distribution of the Mid-Atlantic Winter Flounder Stock off of New Jersey Relative to Seasonal Spawning Movement

**Kaycee Coleman**

*Rutgers University, Institute of Marine and Coastal Sciences, New Brunswick, NJ*

Blue Crab Predation on Juvenile Winter Flounder Demonstrated by a New PCR Method

**Jackie L. Collier, Sean Fitzgerald, Lyndie A. Hice, Mike G. Frisk, and Anne E. McElroy**

*Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY*

Restoring Winter Flounder (*Pseudopleuronectes americanus*) Populations on Martha's Vineyard, Massachusetts Through Stock Enhancement

**Shelley A. Edmundson<sup>1</sup>, Elizabeth A. Fairchild<sup>1</sup>, Warren Doty<sup>2</sup>, Nathan Rennels<sup>1</sup>, John Armstrong<sup>2</sup>, Brett Stearns<sup>3</sup>, Serel Garvin<sup>3</sup>, Danielle Ewart<sup>4</sup>, and David Grunden<sup>4</sup>**

*<sup>1</sup>University of New Hampshire, Department of Biological Sciences, Durham, NH, <sup>2</sup>Dukes County/Martha's Vineyard Fishermen's Association, Menemsha, MA, <sup>3</sup>Wampanoag Tribe of Aquinnah, Aquinnah, MA, <sup>4</sup>Tisbury and Oak Bluffs Shellfish Departments, Vineyard Haven, MA*

Age, Settlement and Growth of Young-of-the-Year Winter Flounder  
(*Pseudopleuronectes americanus*) in Long Island Bays

**Brian K. Gallagher, Lyndie A. Hice, Anne E. McElroy, and Michael G. Frisk**  
*Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY*

Development of Models of European Plaice (*Pleuronectes platessa* L.)  
Population Dynamics Incorporating Biological Processes for Use in Risk Assessment of  
Management Options II: Settlement and the Nursery Ground Phase in the Eastern Irish  
Sea

**Audrey J. Geffen<sup>1,6</sup>, Philip Davison<sup>2</sup>, Clive J. Fox<sup>2,5</sup>, Richard M. Hillary<sup>3</sup>, Geoff P.  
Kirkwood<sup>3</sup>, Paul McCloghrie<sup>2</sup>, Richard D. M. Nash<sup>1,4</sup>, Helen Rossetti<sup>1</sup>, and Natasha  
Taylor<sup>2</sup>**

<sup>1</sup>Port Erin Marine Laboratory, Port Erin, Isle of Man, British Isles, <sup>2</sup>CEFAS, Pakefield  
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<sup>4</sup>IMR, Bergen, Norway, <sup>5</sup>Scottish Marine Institute, Oban, Argyll, Scotland, UK,  
<sup>6</sup>University of Bergen, Department of Biology, Bergen, Norway

Advances in Tagging Technologies and their Applications in the Field

**Thomas Gray<sup>1</sup>, Tony Tucker<sup>2</sup>, Warren Joyce<sup>3</sup>, and Jamie Walker<sup>4</sup>**

<sup>1</sup>Desert Star Systems LLC, Marina, CA, <sup>2</sup>Mote Marine Lab, Sarasota, FL, <sup>3</sup>Bedford  
Institute of Oceanography, Dartmouth, Nova Scotia, Canada, <sup>4</sup>Billfish Research Project,  
Columbia, SC

Larval Development and Salinity Tolerance of Japanese Flounder (*Paralichthys  
olivaceus*) from Hatching to Juvenile Settlement

**Qindan Guo, Youji Wang, and Weiqun Lu**

*Shanghai Ocean University, College of Fisheries and Life Science, Shanghai, China.*

Bilateral Modeling of Jaw Force and Skull Kinetics in the Gulf Flounder, *Paralichthys  
albigutta*

**Natasha Hall and Austin W. Francis, Jr.**

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Temporal Influences on Abundance and Size Distributions of Flatfishes in a Shallow  
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**Robert Kiser and Mary Carla Curran**

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Elucidating the Taxonomic Status of Tonguefishes Presently Identified as *Symphurus  
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**Mao-Ying Lee<sup>1,2</sup>, Thomas A. Munroe<sup>3</sup>, and Kwang-Tsao Shao<sup>1</sup>**

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Interannual Variation in Size Distribution of the Benthic Flatfish, *Pseudopleuronectes americanus*, in Clinton Harbor

**Amy J. Mallozzi and B. Patrizzi**

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Parametric Model Selection of Fish Age and Size at Maturity: An Application with Different Stocks of Winter Flounder

**Richard S. McBride**

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Development of Models of European Plaice (*Pleuronectes platessa* L.) Population Dynamics Incorporating Biological Processes for Use in Risk Assessment of Management Options I: The Egg and Larval Phase in the Eastern Irish Sea

**Richard D. M. Nash<sup>1,4</sup>, Philip Davison<sup>2</sup>, Clive J. Fox<sup>2,5</sup>, Audrey J. Geffen<sup>1,6</sup>, Richard M. Hillary<sup>3</sup>, Geoff P. Kirkwood<sup>3</sup>, Paul McCloghrie<sup>2</sup>, Helen Rossetti<sup>1</sup>, and Natasha Taylor<sup>2</sup>**

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Site Dependence or Density Dependence: Using Geospatial Analysis to Test Models of Habitat Use and Inform Conservation and Management I. Yellowtail Flounder (*Limanda ferruginea*) on Georges Bank

**Jose J. Pereira<sup>1</sup>, Eric T. Schultz<sup>2</sup>, and Peter J. Auster<sup>3</sup>**

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Spermatogenesis, Reproductive Maturation, and Spawning Seasonality of Male Winter Flounder, *Pseudopleuronectes americanus*

**Emilee K. Towle, David W. McElroy, Yvonna K. Press, and Richard S. McBride**

*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA*

Detecting an Environmental Gradient in Maturity of Winter Flounder (*Pseudopleuronectes americanus*) Stocks: Does Thermal Habitat Create Spatial Heterogeneity of Life History Parameters within Stock Boundaries?

**Megan Winton, Richard McBride, Mark Wuenschel, Paul Nitschke, and Mark Terceiro**

*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA*

Burying Ability of Cage-conditioned Japanese Flounder Reared For Stock Enhancement  
**Nicola L. Wong<sup>1</sup>, Michelle L. Walsh<sup>1,2</sup>, Elizabeth A. Fairchild<sup>1</sup>, Reiji Masuda<sup>2</sup>, and Yoh Yamashita<sup>2</sup>**

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Long-term Data Sets on Fishery Resource Occupation of NY/NJ Harbor: What Have We Learned and Where Do We Go from Here?

**Sarah Zappala<sup>1</sup>, Jenine Gallo<sup>2</sup>, Catherine Alcoba<sup>2</sup>, and Douglas Clarke<sup>3</sup>**

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Feeding Kinematics of the Winter Flounder, *Pseudopleuronectes americanus*

**Hannah Zook and Austin W. Francis, Jr.**

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# Abstracts

## Oral Presentations

## **Evaluating Freshwater Residence Patterns in Southern Flounder From Subtropical Estuaries**

**Benjamin Walther and Megan Nims**

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We used otolith chemistry to characterize patterns of movement into freshwater habitats by southern flounder (*Paralichthys lethostigma*) from the Gulf Coast of South Texas. Previous research conducted in the northern Gulf of Mexico and North Carolina has shown that southern flounder typically reside in freshwater for significant periods of time during the juvenile life history stage. However, the prevalence of a low salinity residency period in southern flounder in Texas has not been tested previously. Migratory patterns were determined using laser ablation ICP-MS to quantify life history profiles of otolith Ba/Ca ratios and identify movements across salinity boundaries. On average, southern flounder spent 15% of their lifetimes in freshwater habitats, but individual variability was high. Although the majority of individuals enter freshwater at some point during their lives, approximately 42% of the sampled fish never moved into freshwater. This work demonstrates the high degree of variance in migratory patterns for southern flounder and stands in contrast to the traditional assumption that this species requires freshwater during its early life history. Given the precipitous decline in southern flounder along the coast of Texas in recent decades, a thorough understanding of habitat use patterns is required for effective future management.

**Winter Flounder Larvae in Great Salt Pond and Old Harbor  
Block Island, Rhode Island 2012**

**Grace Klein-MacPhee<sup>1</sup>, Eric G. Schneider<sup>1</sup>, Valerie A. Cappola<sup>2</sup>,  
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Ichthyoplankton collections were made on Block Island, Rhode Island at eight stations, three in Old Harbor and five in the Great Salt Pond from February through May 2012. These locations are dredged periodically and it is important to know when and where winter flounder early life stages occur so that a dredging window can be established to minimize effects on this important commercial and recreational species. Flounder larvae were most abundant at stations 5 (105 total, 238/100m<sup>3</sup>) and 1 (98 total, 203/100m<sup>3</sup>) in the Great Salt Pond and least abundant at station 8 (14 total, 36/100m<sup>3</sup>) in Old Harbor. More flounder were collected in the pond (mean total 91, 144/100m<sup>3</sup>) than in the harbor (mean total 32, 83/100m<sup>3</sup>). Flounder were collected in all months, the maximum number in March and the minimum in May. Numbers collected in February (260/m<sup>3</sup>) and the first collection in March (284/100 m<sup>3</sup>) suggests that hatching began in January possibly in response to warmer temperatures. Water temperatures were relatively warm, averaging 5.85 °C in February, 8.06 °C in March, 10.43 °C in April and 11.05 °C in May. Yolk sac stages were most abundant in February and March, and eye migration stages in April and May, however yolk-sac stages were collected in all months and eye migration only in April and May. Eggs were collected at Stations 3, 4, and 5 in the pond and 6 in the harbor indicating closeness to spawning areas.

**Historical Abundance of Juvenile Summer Flounder  
(*Paralichthys dentatus*) in Rhode Island  
Estuaries and Tidal Rivers**

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The summer flounder, *Paralichthys dentatus*, is a temperate flatfish that utilizes Mid-Atlantic estuaries during the juvenile, post-settlement stage. Recent anecdotal observations, however, have noted a northward shift in the range of these juveniles that now encompasses the Narragansett Bay (RI/MA, USA). Thus, the objectives of this study were twofold: (1) determine if there has been a significant increase in the annual abundance of larval and juvenile summer flounder in Narragansett Bay, and (2) identify if warmer winter water temperatures have contributed to such an increase. Temporal changes in temperature and flounder abundance in the Bay and surrounding coastal ponds were synthesized from historical data provided by the Rhode Island Department of Environmental Management, Normandeau Associates, Roger Williams University, and University of Rhode Island's Graduate School of Oceanography. Analysis revealed no change in the annual abundance of flounder larvae. Conversely, the annual abundance of age-0 and age-1 juveniles has increased significantly in the Bay, though not in the coastal ponds. Juvenile flounder abundance also exhibited a positive relationship with winter water temperature, although this relationship was not significant with the exception of the coastal pond age 0s ( $p < 0.05$ ). Accordingly, warmer winter temperatures appear to reduce overwintering mortality during the transition from plankton to post-settlement juveniles, yet a multitude of environmental factors likely contribute to the observed patterns. As a result, future analysis will focus on possible range shifts of the adult spawning stock biomass, the effect of the North Atlantic Oscillation, and zero-inflated models.

**Comparing Ages of Winter Flounder, *Pseudopleuronectes americanus*,  
Using Scales and Otoliths: Is Better Accuracy Really Worth  
Slowing Down Production Processing?**

**Grace Thornton and Eric Robillard**

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Historically, scales have been used to age winter flounder, *Pseudopleuronectes americanus*. A 1993 study comparing scales vs. whole otoliths found no significant difference in age determinations for young winter flounder (<5 years of age), but recommended that otoliths be used for older fish (>5 years of age). Scales for aging are routinely collected from winter flounder landed from all three US winter flounder stocks (Gulf of Maine; Georges Bank; Southern New England) because of economical and technical advantages, but otoliths are also collected from winter flounder captured in Northeast Fisheries Science Center research vessel surveys. Using scales, whole otoliths, and sectioned otoliths sampled from winter flounder landed commercially from Georges Bank, we compared age estimates derived from these structures and found systematic disagreements, with scale and whole otolith ages generally younger than the ages from sectioned otoliths. This under-ageing affects age compositions, which could potentially influence estimates of spawning stock biomass and fishing mortality. We discuss the costs and benefits of each method, with a recommendation that sectioned otoliths be used for ageing winter flounder to provide more accurate data for stock assessments.

**Temporal Patterns of Flatfish Recruitment to the Moon River, Georgia****Austin W. Francis, Jr.**

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To identify the temporal occurrence and abundance of flatfish recruitment to the Moon River, ichthyoplankton was collected weekly during a night flood tide from April 2009 until December 2011. For 2009 and 2010, two deployments of 30 minutes each were made using a single bridled net. For 2011, three deployments of 30 minutes each were made using two nets, one bridled and one bridle-less. Standard measurements during collections included water depth, salinity, temperature, dissolved oxygen, and pH. In the field, larval and juvenile flatfishes were preserved in 10% unbuffered formalin. In the laboratory, ichthyoplankton samples were transferred to 70% ethyl alcohol and identified to the lowest possible taxon. Only 1.75% of the total catch (23,485) included flatfishes (411). Despite the greater sampling effort in 2011, fewer flatfish were collected than in 2009 and 2010. Nearly all collected flatfishes were late metamorphic larvae or post-metamorphic juveniles. The majority of flatfishes (378) were tonguefishes (Family Cynoglossidae) with *Symphurus plagiusa* (74.34%) the most common species. Tonguefishes were present in samples from May to September of each year. Many of the remaining flatfishes belonged to the Family Paralichthyidae (including *Citharichthys spilopterus*, *Etropus microstomus*, and several species of *Paralichthys*). These large-tooth flounders were only present in samples from January to April. The Family Achiridae was represented by just one species, *Trinectes maculatus*, collected only in July and August of 2011. The seasonal occurrence of flatfishes corresponds with previously published studies. However, there was considerable inter-annual variation in the representation of many species.

## Recruitment Decline in Juvenile Benthic Marine Fish in the Norwalk and Saugatuck Estuaries from 1991 to the Present

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Harbor Watch, a Program of Earthplace in Westport, CT, in conjunction with students from Wilton High School, has been conducting summer trawl surveys of marine, juvenile benthic fish in the Norwalk River Estuary from 1991 until the present. This survey is based on a discontinued CT DEEP benthic fisheries research program. Results from the early 1990's show a harbor bottom rich in diversity which served as the primary breeding ground and nursery for winter flounder (*Pseudopleuronectes americanus*). The number of species routinely collected per tow ranged from 9 to 12 with a total catch of 200 to over 900 fish per season, most of which were *P. americanus*. Since the early 1990's, the number of benthic, juvenile recruits has declined steadily. During the 2012 season, most marine benthic fish were represented in the trawls by no more than five individuals. Catch per unit effort (CPUE) declined by 1.8 from 9 to 12 CPUE in the early 1990's. Total numbers of all fish caught in the last five years ranged from 50 to 180 fish and *P. americanus* still make up the majority of the catch. All fish caught appeared to be in good physical condition. This decline in benthic recruitment occurred concurrently with other local and regional events including a population decline in American lobster (*Homarus americanus*) in the late 1990's, a major harbor fish kill followed by an extended dredging program during 2005 and the presence of a large imbalance of blue crab (*Calinectes sapidus*) during 2010. There is presently an oversupply of natural predators that include striped bass and cormorants. Other problems specific to Norwalk Harbor include seasonal decline in dissolved oxygen to hypoxic levels in the upper harbor, nutrient and bacterial pollution carried by the Norwalk River, pollution input from an aging, harbor infrastructure, a two degree increase in the average bottom temperature since 1989 and the unknown impact of medical waste on fisheries biology.

Saugatuck Estuary was also sampled by trawling and compared to fisheries surveys from the early 1990's. This estuary has a different environmental history as compared to Norwalk Estuary and is characterized by higher levels of dissolved oxygen, excellent flushing conditions, a lack of industrial applications, and minor development of large estates located on one to two acre lots along the shoreline. Both harbors appear to show recruitment depletion of benthic juvenile fish. These observed conditions in two major harbors with different environmental characteristics lead us to question whether these same conditions exist in other neighboring harbors along the Connecticut coast in western Long Island Sound.

**Winter Flounder Populations in Two Estuaries on  
Martha's Vineyard, Massachusetts**

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Winter flounder populations were assessed temporally and spatially in two estuaries, Lagoon Pond and Menemsha Pond, in Martha's Vineyard, Massachusetts from November 2010 to October 2011. Within each estuary, four sites were sampled biweekly throughout most months with triplicate 100-m<sup>2</sup> beam trawl tows and 550-m<sup>2</sup> beach seine hauls. In addition, water quality data were collected (bottom temperature, salinity, and dissolved oxygen) as well as benthic cores to identify and quantify juvenile winter flounder prey organisms.

Although present in both estuaries at all sampling sites, winter flounder were more abundant in Menemsha than in Lagoon Pond, and caught in higher numbers by beam trawl than beach seine. Highest annual mean catch-per-unit-effort was at Clam Cove in Menemsha Pond. Seasonally, winter flounder catch was highest from May through November, though this varied depending on location.

These data were a component of a larger ecosystem study of Lagoon and Menemsha Ponds to determine optimal release strategies (release site, release season, fish release size) for hatchery-reared winter flounder raised in the Wampanoag Tribal hatchery in Aquinnah, Massachusetts.

## Variation in Condition of Young-of-the-Year Summer Flounder From Virginia Estuaries

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Fisheries managers typically use indices of relative abundance of young-of-the-year fish to assess year-class strength, however purportedly strong year classes may not always produce subsequent recruits to the fishery. The condition of individuals in a year class has the potential to influence recruitment variability due to differential survival of poor- and well-conditioned individuals. We assessed the performance of several metrics presumed to measure condition of young-of-the-year fish (Fulton's K, hepatosomatic index, and fatmeter lipid estimates) by correlating them with lipid and energy content. For summer flounder, *Paralichthys dentatus*, Fulton's K reasonably assessed condition as measured by energy density determined by bomb calorimetry ( $R^2=0.6$ ). We also investigated the temporal dynamics of condition for summer flounder throughout the year, and examined spatial variation in condition of fish among nursery areas in and around Chesapeake Bay. Interestingly, mean condition was highest for fishes from December 2011 to February 2012 ( $K>1.006$ ). Fishes from the coastal lagoons around Oyster, VA ( $K=0.983$ ), had significantly higher mean condition than fishes from areas sampled in the tributaries ( $K=0.925$ ), but neither were different from regions of Chesapeake Bay ( $0.942<K<0.957$ ).

## **Laboratory Investigations of Winter Flounder Egg Interactions With Suspended and Bed Sediment**

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The attributes of winter flounder (*Pseudopleuronectes americanus*) spawning habitat within highly modified northeastern estuaries are of interest for several reasons. Foremost is the need to protect remaining habitat and to minimize impacts to eggs from development through hatch. Exposure to suspended sediments is one potential source of disturbance that may affect hatching success. Another factor governing the interaction between winter flounder eggs and sediment particles is the strength of egg adhesion to the substrate, which can influence the transport and fate of eggs during the period between fertilization and hatching. Experiments were conducted to examine several aspects of egg-sediment interactions. Critical shear stresses of erosion of fertilized eggs were determined in time series after their contact with natural and artificial sediment surfaces. Settling velocities of eggs were determined, including eggs exposed to elevated concentrations of total suspended sediments. In brief, the strength of bonding to the substrate was determined within minutes of fertilization. Once water hardened, egg surfaces lost adhesive qualities. Exposure to high suspended sediment concentrations reduced bond strength. Sediment bed properties also influenced bond strength. Findings have implications for predicting the retention or transport of eggs from their spawning site.

**Can Variation in Fecundity of Winter Flounder  
(*Pseudopleuronectes americanus*)  
Be Explained By Measures of Condition?**

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Recent analyses of potential annual fecundity (PAF) of female winter flounder have described significant variation across the three stocks in US waters, as well as inter-annual differences. To better understand the underlying causes of this variation, we explored the utility of simple as well as more detailed measures of fish condition to explain variation in and predict relative fecundity (number of oocytes /female body weight). Simple measures included length, weight, and relative condition (Kn). More detailed measures included liver index (HSI), the percentage dry weight (%DW) as a proxy for energy density of liver and muscle tissue, and electrical properties obtained from bioelectrical impedance analysis (BIA). As in prior analyses, data were analyzed over two years across the three stocks, however the current analysis was limited to those individuals with more detailed information on condition and energetic status (n=160). AICc analysis was used to compare models of relative fecundity as a function of condition measures. Given the group-synchronous nature of oocyte development in winter flounder, the mean oocyte diameter (OD) of each fish provides a proxy for time to spawning and was included as a covariate. Models without OD were also evaluated to determine predictive ability without this more rigorous measure. The predictive capacity of simple to complex measures will be discussed. Not surprisingly, models with OD performed better than models without OD (~0.89 vs. 0.69 explained deviance), however in both cases the % DW of muscle and BIA measures explained more variation than stock, Kn, and HSI. The results indicate the importance of muscle energy in fecundity regulation for this species.

## **Comparison of Fecundity and Down-Regulation among Stocks and Years for Female Yellowtail Flounder, *Limanda ferruginea***

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This study developed fecundity estimates for yellowtail flounder, *Limanda ferruginea*, sampled over multiple years from all three US stock areas (Gulf of Maine, GOM; Georges Bank, GB; and Southern New England, SNE). Fish were obtained principally from commercial fishing vessels with supplemental samples from fisheries-independent research surveys. As yellowtail flounder have group-synchronous oocyte development and determinate fecundity, we applied the determinate auto-diametric fecundity method. Gonad histology was analyzed to verify selection of individuals for fecundity estimation and to quantify fecundity down-regulation. Potential annual fecundity (PAF) estimates increased with fish length, and AICc model analysis indicated inclusion of stock and year as interaction terms in the final model. Individual variation was high, but females from SNE typically had the highest PAF at size and those from GOM the lowest. Fish from the GB stock exhibited the greatest variation between years, with higher fecundity at size in 2010 than 2011. The rank order of years with highest and lowest average fecundity was not synchronized among the stocks. Individual variability in fecundity exceeded the level of down-regulation in scale, and down-regulation differed among stocks and years. Consistent with previous yellowtail flounder studies (one from SNE and two from the Grand Banks); a latitudinal trend in fecundity was detected.

## Biophysical Dynamics of Larval Summer Flounder Ingress Into Delaware Bay

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Understanding the biophysical dynamics of larval fish ingress into estuaries is important for identifying processes underlying juvenile ingress of estuary-dependent fishes. In this study, we examined ingress patterns of larval summer flounder (*Paralichthys dentatus*) into Delaware Bay via weekly ichthyoplankton sampling over three ingress periods (late fall through early spring 2007-2008, 2008-2009, and 2009-2010). We also used a coupled larval transport (LTRANS) and a three dimensional hydrodynamic model (MACROMS) to identify how wind patterns and larval behavior affect daily ingress over the 2007-2008 and 2008-2009 ingress periods. To facilitate comparison with concurrent ichthyoplankton sampling, modeled particle ingress from the mouth of Delaware Bay was considered successful if particles were transported to Roosevelt Inlet, Delaware, the site of weekly and daily larval fish collections. A constant daily supply of particles ( $n = 1020$ ) was released at the mouth of the bay and tracked for a period of 5 days to determine how a single wind event affected ingress. Our ichthyoplankton sampling showed that larval summer flounder ingress began in October and ended in March or April depending upon the year. Fish sizes ranged from 7.1 – 15.6 mm SL. Seasonal mean concentration of summer flounder larvae increased from 2007-2010. However, the number of peaks in ingress declined over this same period. Summer flounder have been reported to engage predominately in selective tidal stream transport, specifically flood tide transport (FTT) to gain entry into estuaries (Hare et al., 2005). Our modeling simulations indicate that FTT behavior significantly enhanced larval ingress into Delaware Bay, when compared to passive particle motion ( $p = 0.002$ ). Furthermore, southward alongshore and down-estuary winds enhance larval ingress of particles exhibiting FTT. The model and empirical results indicate that alongshore and along-estuary winds enhance ingress of larval summer flounder at Roosevelt Inlet, Delaware. Additionally, model results show that daily variability in particle ingress is substantial (even with consistent source populations) and suggests that ichthyoplankton time series examining ingress events require sampling at daily frequencies to adequately capture such events. Our results show that species-specific vertical migratory behaviors can dictate which physical processes will act on larval fishes during transport into an estuary and need to be considered when assessing the influence of environmental conditions on juvenile ingress of estuary-dependent fish populations.

## **Inter-Female Differences in Offspring Quality in Summer Flounder, *Paralichthys dentatus***

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All spawning biomass in a fish population is not equal. A critical feature of fisheries that are regulated by fish body size, such as for the summer flounder (*Paralichthys dentatus*) fishery, is that the larger and presumably older fish are culled from the population. These landed fish are more likely to be female and more fecund, and might produce offspring of higher quality than non-captured smaller and sub-legal size fish. The goals of this work were to 1) estimate the magnitude and pattern of inter-female variation in offspring quality, and 2) assess whether any revealed variations are predictable from the size and age of the female parent. First we analyzed existing ichthyoplankton and adult trawl-survey data on summer flounder from the Mid-Atlantic region which showed a clear seasonal progression with egg size increasing as the spawning season advanced. Second, we conducted a series of controlled laboratory experiments to directly quantify variation in the quality of offspring (e.g., sizes of eggs, hatchlings, and feeding larvae; and developmental and survival rates of embryos and larvae). To date, variation and relationships among 31 sets of unrelated sibships have been evaluated. We found differences among sibships in early life-history features (egg size, size at hatching, and larval growth), correlations among these offspring features, and a tendency for egg sizes to increase with female size. From these relationships, we are evaluating the consequences of maternal effects on offspring quality, including the role of time and location of spawning, and the possible consequences of a size-selective fishery.

## **Spatial Predictive Models of Summer Flounder (*Paralichthys dentatus*) Abundance in the New York Bight**

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The New York Oceans and Great Lakes Program is engaged in a planning effort to better manage competing uses in New York's crowded offshore environment. While continuous spatial information on the abundance and distribution of marine species can help inform the planning process, such information is often unavailable. However, point counts of species abundance or presence/absence can be used in conjunction with maps of environmental covariates to produce high-resolution, continuous species distribution maps along with estimates of the error associated with those predictions.

This presentation describes such a method with a case study in the New York Bight. Using data from the NOAA Northeast Fisheries Science Center's bottom trawl survey program, seasonal summer flounder (*Paralichthys dentatus*) abundance was modeled as a function of environmental variables including depth, slope, sea surface temperature, stratification, turbidity, chlorophyll a, zooplankton, sediment grain size and distance from shore/shelf. Generalized linear models (GLMs) were used to determine coefficients for the environmental predictors, and simple kriging (SK) of residuals was used to account for spatial autocorrelation in the data. Model parameters were entered in a GIS to produce the final maps, and model performance and error were assessed using two-fold cross-validation.

Cross-validation statistics suggest models perform fair overall, although this performance varies with season and space. Importantly, models illustrate a seasonal near-shore/offshore migration pattern. This suggests that certain actions in federal waters may have reasonably foreseeable consequences to state resources, and that these actions might be subject to state consistency review.

**Long-term Patterns of Abundance of Blackcheek Tonguefish,  
*Symphurus plagiusa* Linnaeus, (Pleuronectiformes: Cynoglossidae),  
In Lower Chesapeake Bay and its Major Tributaries**

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Blackcheek tonguefish, *Symphurus plagiusa*, is the only species of Cynoglossidae occurring within Chesapeake Bay. In fact, Chesapeake Bay represents the northernmost limit of a resident population of this species, as only sporadic captures are recorded north of this location. All life-history stages are present within the Bay, including newly-recruited juveniles and larger-sized, mature adults, indicating that this population is self-sustaining. Previously, it was suggested that the largest-sized tonguefish move out of the Bay to inhabit nearshore waters on the inner continental shelf. Since 1955, VIMS has conducted a juvenile finfish survey within Chesapeake Bay and its major tributaries. Among flatfishes captured in this survey, blackcheek tonguefish rank among the top five species annually in terms of numbers of individuals captured. Recent abundance data for this species indicate a cyclic pattern, with abundance peaks occurring at nearly decadal intervals followed by several years of low abundance. Factors contributing to these abundance cycles are unknown. Also unknown is whether or not all segments of the population experience periods of high and low abundances. Do abundance cycles reflect only recruitment processes impacting this northernmost population of blackcheek tonguefish? Or do population cycles reflect broad-scale mortality or emigration throughout all segments of the population residing in the Bay? Preliminary data analysis indicates that all segments of the tonguefish population residing in the Bay are equally affected during periods of low abundance supporting the hypothesis of a broad-scale driver that alters the blackcheek tonguefish population at its northernmost limit.

## **Characterization of Summer Flounder Nursery Areas in Virginia**

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Chesapeake Bay and the coastal bays of Virginia's eastern shore serve as nursery areas for summer flounder, yet the contribution of these areas to summer flounder year-class strength is unknown. In Virginia, recruitment of summer flounder is estimated from bottom trawl catches of young-of-the-year fish throughout Chesapeake Bay when fish are available and vulnerable to the gear in September, October, and November. However, early life stages of summer flounder are present in estuaries beginning in early spring. Biweekly samples of young-of-the-year summer flounder were used to determine the relative favorability of nursery grounds in Virginia estuaries during 2011 and 2012; settlement characteristics of cohorts such as size at settlement and recent growth will be determined from otolith analysis. In addition, we will investigate spatial and temporal variation in young-of-the-year summer flounder abundance and growth. Because quality nursery areas are expected to support increased growth and greater survival of flatfish, we expect that young-of-the-year summer flounder will be more abundant in higher quality nursery areas and will exhibit greater growth compared with habitats of lesser quality.

## **Winter Flounder Distribution in Southern New England- Insights from Industry-based Trawl Surveys**

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SMAST scientists collaborated with members of the New England groundfish fleet to complete two industry-based surveys for winter flounder. The first survey was completed on Nantucket Shoals and the Great South Channel between June and October of 2010. The second survey was conducted south of Martha's Vineyard and Nantucket between April and July of 2012. A Generalized Additive Model (GAM) was used to model the catch weights of winter flounder during each survey as a function of geographic and climactic variables. The final model for the Great South Channel survey included four explanatory variables: temperature, depth, latitude and longitude. Winter flounder catches in the Great South Channel were typically greater in the northern and western portion of the study site, and smaller to the south and to the east. The relationship between catch weight and temperature was slightly parabolic, with the largest catches observed between 8 and 11°C. The final model for the 2012 winter flounder survey included three explanatory variables: latitude, longitude and temperature. Winter flounder catches in southern New England were greatest between 10 and 12°C, and declined at temperatures greater than 14°C. Catch weights were lowest in the southern portion of the study site, and generally increased with increasing latitude. Other analysis indicated that the mean size of winter flounder in survey catches was strongly influenced by depth and temperature. Juvenile fish typically dominated the survey catches in shallow waters, while adult fish were usually more numerous in cooler, deeper portions of each study area.

**Winter Flounder Habitat Use in New York/New Jersey Harbor and the Influence of Spring Temperatures on Subsequent Year Class Strength**

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Winter flounder habitat use from January through June in New York / New Jersey Harbor was examined using data collected in the Aquatic Biological Survey (ABS) conducted by the US Army Corps of Engineers in conjunction with the Harbor Deepening Project. In this long-term (2002-2010) study, 5,234 juvenile and adult winter flounder were captured in 2,069 bottom trawl samples collected at approximately 26 stations throughout the harbor. Year-1 juvenile annual CPUEs (catch per unit effort) were highly variable and positively correlated with annual egg abundances (from ABS ichthyoplankton surveys) from the previous year. Adult male CPUEs during the spawning season were positively correlated with annual egg abundances, whereas a similar correlation was not significant for females. Adult abundances peaked in April, the critical feeding period that follows spawning. Mean April water temperatures were positively correlated with both egg abundances the following year and Year-1 juvenile CPUE two years later. A similar correlation between April temperatures and Year-1 juvenile abundances two years later was observed in another estuarine system for which long-term data were available (Niantic Bay, CT). Temperature-enhanced benthic secondary production may increase prey availability for foraging adults that need to restore energy reserves in order to reproduce the following year. A direct examination of the timing of spring benthic secondary production and winter flounder estuarine habitat use is needed to more fully understand the observed relationship.

## **Using Flatfish Research to Maintain K-12 Student Interest in Science**

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Ocean literacy concepts can be woven into a variety of K-12 activities. We will present activities coauthored by a university scientist and teachers. One lesson focuses on flatfish shape and growth, as students act out the various life stages of a flounder. Another empowers students to teach each other about the fish they have studied. We explain how scientists sort their fish catches, which provides a framework for the appreciation of marine diversity and fish abundance. Finally, we discuss how some species undergo migration, and when we put that in the context of movement relative to body lengths, the students can see that the comparative distance a fish travels is quite large. Each lesson incorporates Ocean Literacy Principles and has modifications that enhance the focus on mathematics, graphing, and/or language arts.

**The Influence of Tidal Cycle on the Feeding of Juvenile European Plaice, *Pleuronectes platessa* L., on a Small Nursery Ground (Port Erin Bay, Isle of Man) in the Irish Sea**

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In areas where there is a tidal excursion and juvenile fish utilize the intertidal areas for foraging and/or as a refuge from predators, there is the possibility of circadian disruptions to behavior patterns. This can take the form of periodic variations in feeding over tidal, lunar and annual cycles. These disruptions could have an effect on growth rates and be an influence on structuring shallow water fish populations, e.g., juvenile European plaice. Previously we have shown a seven-day periodicity in check marks on the otoliths, here we investigate a potential cause of growth disruptions, namely variations in feeding patterns.

Juvenile plaice were sampled from Port Erin Bay, Isle of Man between 22nd June and 29th August 1990. Sampling at 1 m depth was undertaken on nine occasions over 12h periods. In the laboratory all plaice were measured, the guts removed and the stomach and hind gut awarded a percent fullness on a scale of 0 to 100%. All gut contents were identified to major taxa and counted.

Feeding at neap tides is very low, either as a direct result of fish inactivity or because low subtidal or high intertidal prey is inaccessible. Predation pressure may also be higher at neap tides, especially in Port Erin Bay where HWNT occurs at dawn and dusk. Feeding activity was higher at mid-tide levels of both daily and lunar tidal cycles. At spring tides stomach fullness changes rapidly, usually increasing as the tide ebbs, which coincides with either mid-afternoon or pre-dawn periods.

**The Caudal Neurosecretory System (CNSS): Function in Salinity  
Adaptation of the Euryhaline Flounder, *Platichthys flesus***

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The caudal neurosecretory system (CNSS) is a part of the stress response system, a neuroendocrine structure unique to fish. Large peptide-synthesizing neurons, Dahlgren cells, are located in the terminal segments of the spinal cord, and project to a neurohaemal organ, the urophysis, from which neuropeptides are released into the circulation. CNSS is the major site of expression and secretion of CRF, UI and UIL. These peptides are differentially expressed with co-localization of up to two in a single cell. Dahlgren cells display a range of electrical firing patterns, including characteristic bursting activity, which is dependent on L-type  $\text{Ca}^{2+}$  and Ca-activated  $\text{K}^{+}$  channels. Electrophysiological and mRNA expression studies have examined changes in response to altered physiological demands. Bursting activity is more robust and more Dahlgren cells are recruited in seawater compared to freshwater-adapted fish and this is mirrored by a reduction in mRNA expression for L-type  $\text{Ca}^{2+}$  and Ca-activated  $\text{K}^{+}$  channels. Acute seawater/freshwater transfer experiments support a role for CNSS in adaptation to changing environmental salinity. We hypothesize that the Dahlgren cell population is reprogrammed during salinity adaptation, and this is seen as changes in gene expression profile and electrical activity. The CNSS shows a striking parallel with the hypothalamic neurohypophyseal system, and provides a highly accessible system for studies of neuroendocrine mechanisms. Furthermore, the presence of homologues of urotensins throughout the vertebrates has sparked new interest in these peptides and their functional evolution.

## **Testing of a Modified Groundgear to Reduce the Catch of Flatfish In the Large Mesh Groundfish Trawl Fishery**

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The groundfish fishery in the New England region has transitioned to a catch-share management system with annual catch limits for regulated groundfish. Within this management scheme, the ability to reduce bycatch of sub-legal and non-retention flatfish would allow for optimization of catch allocations while promoting sustainable fishing practices. A modified groundgear with “escape windows” was tested to examine if the catch of winter flounder (*Pseudopleuronectes americanus*) could be reduced in the Southern New England region. The objective was to minimize the catch of winter flounder, a non-retention stock, while retaining Atlantic cod. Two proof-of-concept projects, funded by the Commercial Fisheries Research Foundation, were completed using comparative fishing trials onboard a commercial otter trawl vessel in March of 2011 and April of 2012. During the first proof-of-concept project, the modified groundgear was tested along with a large mesh panel in the belly of the trawl behind the fishing line. Results indicated that the use of the groundgear in conjunction with a large mesh panel resulted in a significant loss of legal Atlantic cod. The second proof-of-concept project focused on testing the modified groundgear as the sole bycatch reduction device. Results showed that the modified groundgear without a large mesh panel reduced the catch of the winter flounder as well as other flatfish of concern and juvenile Atlantic cod while maintaining catch rates of legal-sized cod. Research will continue to test the modified groundgear on Georges Bank to reduce the catch of yellowtail flounder (*Limanda ferruginea*).

**Association of Estuarine Bivalve Shell Habitats to the  
Historic Winter Flounder, *Pseudopleuronectes americanus*,  
Fyke Net Fishery of Eastern Connecticut**

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For centuries the presence of estuarine shell, especially bivalve shell litter, has been found in association with flounder populations. In eastern Connecticut, at the turn of the century, coastal coves supported a large fyke net winter flounder fishery. According to Hugh M. Smith, writing in an 1889 US Fish Commission Report, the eastern Connecticut fyke net fishery at that time was the largest in the nation and totaled 440 fyke nets. At times this flounder fyke net fishery also extended into southern Rhode Island salt ponds.

Winter flounder inhabited reaches of the Mystic, Pawcatuck, Niantic, Thames, and Connecticut Rivers in 5 to 15 feet of water. Fyke nets were mobile fish traps set on bottoms that were firm and sandy. Firm or hard bottoms and those containing clam and oyster populations were some of the best sites in which to set fyke nets.

By 1989, a full century after Smith's report, eastern Connecticut coves had largely failed for winter flounder. The importance of clean, hard bottom containing bivalve shell habitat (gravel and sand bars), together with colder temperatures, are frequently overlooked. Eastern Connecticut coves contain a habitat history that today no longer resembles habitat conditions described by Smith and reflects a far different habitat quality – one that responds to energy and climate drivers that have vastly changed since the last century.

**The NOAA Ocean Acidification Plan:  
Designing an Experimental System to Test the Effects of  
Water Conditions Specific to Ocean Acidification  
On the Early Life Stages of Flatfish**

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NOAA has been mandated by the Federal Ocean Acidification Research and Monitoring Act of 2009 (FOARAM) to establish an ocean acidification program, assess regional impacts of ocean acidification, and research adaptation strategies. NOAA currently has six regions working on these aspects of the Ocean Acidification research plan. Conducting ocean acidification research in a laboratory setting can present many unique obstacles associated with facility location, water supply, water quality, ambient conditions, and experimental variables. These obstacles are often compounded when attempting to create ecologically/biologically relevant experimental conditions while still achieving standardized pH/pCO<sub>2</sub> levels proposed by the ocean acidification research community. The NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory at Sandy Hook, New Jersey has designed a system for exposing a variety of fish species at different early life stages that is customizable to many different variables, in many different combinations. We have designed and implemented an experimental system that can accommodate a wide range of distinct values for multiple variables. Our large scale system utilizes a flow through design and has the ability to manipulate carbonate chemistry, temperature, salinity, flow rates, and dissolved oxygen, as well as biogeochemicals like ammonium and sulfide.

## **The Effects of Ocean Acidification on the Early Life-Stages Of Commercially Important Flatfish of the Northeast USA**

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Effects of high CO<sub>2</sub> on finfish and related acidification of our oceans are likely to differ across life stages and species, to be subtle, and to interact with other stressors. We developed a strategic experimental framework with three key elements: 1) use multiple marine finfish species of relevance to the northeastern USA that differ in their ecologies including spawning season and habitat; 2) implement a wide yet realistic range of future ocean CO<sub>2</sub> levels and water temperatures, and 3) measure diverse sets of responses related to fitness and the likelihood of fish recruitment. The response measures included various metrics of viability, physiology, histopathology, growth, development, morphometry, and behavior expressed during early life. To date, separate factorial experiments have been implemented on summer flounder (*Paralichthys dentatus*) and winter flounder (*Pseudopleuronectes americanus*). Initial results from summer flounder maintained at one temperature (16 °C) revealed that embryo survival was compromised by pH < 7.7 (pCO<sub>2</sub> > 790 ppm). These results were similar across offspring groups (i.e., eggs from different females). Winter flounder larvae subjected to multiple temperatures and CO<sub>2</sub> levels were longer at hatching under the coolest and more acidic conditions tested (4 °C and pH ≤ 7.5). Additional responses of both flounder species are currently being assessed. This research will aid ecologists and resource managers in identifying which species types, life stages, and organismal subsystems are most vulnerable to projected future levels of acidification and water temperatures of our oceans, and which responses are the best bio-indicators of these environmental changes.

## **An Initial Look at Developmental Success of Winter Flounder Ichthyoplankton in New York / New Jersey Harbor**

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Winter flounder eggs and larvae, collected by the US Army Corps of Engineers during the 2011 Aquatic Biological Survey, were examined to determine whether morphological features that may be associated with overall condition differed among areas of the NY/NJ Harbor or over time within the spawning season. Egg and larval morphological characteristics were measured at 90x and 25x magnifications, respectively. Egg diameter and seven larval traits (i.e., total length, head depth, myotome height, body area, notochord length, eye diameter, and stage 1 larval yolk sac [YS] area) were identified as features that could be reliably measured at high magnification and are the traits analyzed in this study. Yolk sac larval total length differed among harbor areas with smaller YS larvae occurring in the Lower Bay compared to the Arthur Kill/ Newark Bay and Upper Bay areas. This size difference among harbor areas was still apparent for stage 2 larvae, but did not exist for larval stages 3 or 4. Yolk sac area and YS larval total length were negatively correlated within harbor areas, reflecting the conversion of endogenous energy reserves into larval growth. Yolk sac area in Lower Bay larvae was significantly smaller than that of YS larvae from other harbor areas and small YS larvae with small YS areas were collected exclusively in the Lower Bay, indicating little growth potential exists for these larvae prior to entering the first feeding stage. Additional analyses are being conducted to determine whether egg size differs among harbor areas in a pattern consistent with YS larval size. Other YS larval traits are being analyzed to further explore spatial and temporal patterns in larval quality throughout the harbor.

## **A First Step toward Analyzing Morphometrics of Winter Flounder Ichthyoplankton in New York / New Jersey Harbor**

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The US Army Corps of Engineers has developed an extensive Aquatic Biological Sampling (ABS) program to inform dredging management practices and promote the protection of early life history stages of winter flounder, *Pseudopleuronectes americanus*, within the New York / New Jersey Harbor. In 2011, the program was expanded to include measuring morphometric features of winter flounder eggs and larvae that may reflect overall condition. Egg diameter and stage 1 egg yolk diameter were measured and traits measured for larvae included total length, head depth, myotome height, body area, notochord length, eye diameter, jaw length, and stage 1 larval yolk-sac area. Two analyses were conducted as quality control measures that demonstrated the reliability of the data and established the comparability between the higher magnifications (90x and 25x for eggs and larvae, respectively) used in 2011 and the lower magnifications (25x and 10x for eggs and larvae, respectively) used in archived images. Results indicated which morphometric features could be accurately measured at high and low magnifications. At high magnification, early life stage larval jaw length and egg yolk diameter were difficult to measure accurately. At low magnification, larval yolk-sac area, early life stage jaw length, and egg yolk diameter were difficult to measure and are not recommended for use in analytical studies. These results identified a suite of egg and larval morphometric features that can be reliably measured and analyzed to determine whether winter flounder early life stage condition differs spatially and/or temporally within the harbor.

**The Influence of Cage-conditioning on the Performance and Behavior  
of Japanese Flounder Reared for Stock Enhancement:  
Burying, Feeding, and Threat Response**

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Flatfish reared for stock enhancement often exhibit irregular behavioral patterns compared with wild conspecifics and these "deficits", mostly attributed to the unnatural characteristics of the hatchery environment, are assumed to translate to increased predation risk. Initially releasing fish in predator-free conditioning cages, a strategy currently being engaged by some hatcheries in Japan, may help flatfish adjust to the wild environment, establish burial skills, begin pigment change, recover from transport stress, and experience natural (live) food sources before full release into the wild. However, the impact on the performance and behavior of fish has yet to be fully assessed. We conducted video trials with 10-cm hatchery-reared Japanese flounder in sand-bottomed aquaria to assess the behavior of four treatments of flounder: (1) reared fish cage conditioned for 7 d in the shallow coast, (2) reared fish directly from hatchery tanks, (3) wild fish, and (4) reared fish that were released directly from hatchery tanks into the wild and recaptured after 6 d at large. Burying ability, predation on live 2-cm Japanese flounder, and threat response to a model predator (moving, eel-shaped aquarium tank aerator) were assessed. At the end of trials, fish were preserved and the amount of prey consumed was verified by stomach contents analysis. Wild fish buried and attacked most, followed by conditioned, reared-then-released, and non-conditioned fish. Wild and conditioned fish revealed much lower variation in total movement duration, which corresponded with lower levels and variation in prey vertical movement. Fish of all condition types exhibited a lower number of attacks and off-bottom swimming events, and a lower movement duration when the model predator was in motion versus when it was still. This study is the first to evaluate the behavior of hatchery-reared flatfish that have been cage-conditioned or released-then-recaptured. In addition, we provide evidence that cage conditioning of flounder can enhance the performance of released fish.

## **Regional Spatial Dynamics of Yellowtail Flounder On the Northeast US Shelf**

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Populations of yellowtail flounder, *Limanda ferruginea*, a managed groundfish experiencing low abundances in recent years, have shifted north over the time period 1963-2008. Changes in spatiotemporal distribution could affect population or stock structure and thus have management implications (Link et al. 2011). Three stocks are defined for management purposes on the northeast shelf (NES): Cape Cod/Gulf of Maine (GOM), Georges Bank (GB), and Southern New England/ Mid-Atlantic (SNE/MAB). We examined the effects of density-independent (e.g., environmental) and density-dependent (demographic) processes on yellowtail flounder abundance and distribution across sex and ontogenetic stage (adult and juvenile) from 1963 to 2008. Analytical methods used include geostatistical aggregation curves and both spatially invariant regression models and spatially variant or geographically weighted regression models. Regression models were formulated as yellowtail abundance and distribution as function of bottom temperature, population estimates, and sediment grain size across sex and ontogenetic stage (adult and juvenile) to explore changes and shifts under varying bottom temperature and population estimate scenarios. We found density dependence plays a role in driving the spatial dynamics across all gender and ontogenetic stages in the SNE/MAB denoting probable habitat expansion to GB and GOM. We found bottom temperature is a significant density independent driver of spatial dynamics across ontogenetic stage and gender denoted as an increase shift of the population north to GB and southwestern GOM. Results suggest yellowtail stock dynamics are changing and these changes may influence current management practices

**New Western Pacific Species of Bothid Flatfishes  
(*Lophonectes*: Pleuronectiformes: Bothidae)**

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On-going studies of marine fishes inhabiting waters around New Zealand have discovered numerous undescribed species, including several flatfishes. Among flatfishes found in these waters, several poorly-known species are now known by a larger series of specimens, and several nominal species currently residing in synonymy should be recognized as valid. These include members of *Lophonectes* Günther, 1880, originally created for *L. gallus*, collected in Bass Straits, Australia. *Lophonectes* is distinguished by the presence in mature males of several, elongate, anterior dorsal-fin rays, and well-developed cephalic tubercles. Female *L. gallus* have elongate anterior dorsal-fin rays that are shorter and fewer than those occurring in males, but they lack cephalic tubercles featuring so prominently in mature males. *Arnoglossus mongonuiensis* Regan, described from a small series of syntypes collected off New Zealand, was later transferred to *Lophonectes*, and then subsequently considered to be a junior subjective synonym of *L. gallus*. Comparisons of a large series of specimens from Australia and New Zealand reveal that both nominal species are valid. Additionally, two other undescribed species of *Lophonectes* were discovered to inhabit waters off New Zealand. One was collected on Wanganella Bank off northwest New Zealand, while the second is known from a small series of species taken in shallow water at the Kermadec Islands. Redescriptions of *L. gallus* and *L. mongonuiensis*, and descriptions of the two undescribed species are provided along with information on size and maturity, sexual dimorphism, and geographic distribution for all four species now considered as members of *Lophonectes*.

**Changes in Larval, Juvenile, and Adult Yellowtail Flounder  
Distributions and Habitat Use on the Northeast US Shelf  
Over the Last Four Decades.**

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Changes in climate and fishing pressure affect adult fish distributions, leading to shifts northward and into deeper waters for many species of the northeast US continental shelf (Lucey and Nye 2010, Nye et al. 2009). Shifts in distribution of adults may cause shifts in spawning distribution, potentially affecting larval dispersal, juvenile settlement patterns, and ultimately recruitment. The NOAA Fisheries, Northeast Fisheries Science Center has conducted bottom trawl and ichthyoplankton sampling along the northeast US continental shelf since the early 1960's. The shelf-wide surveys are conducted from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia, and overlapped in time during the Marine Resources Monitoring, Assessment and Prediction (MARMAP; 1977 - 1987) and Ecosystem Monitoring (ECOMON; 1999 - present) programs. We examined yellowtail flounder distributions and habitat use for three life stages: larval, juvenile, and adult (males and females) between the two time periods to explore changes over the four decades. The relative proportion (percent of annual sum) of estimated absolute number of larvae, juveniles, and adults within each of 47 strata by year and season was calculated. Significant differences of larval, juvenile, and adult proportion by stratum between MARMAP and ECOMON for several seasons were tested using a Kruskal-Wallis H test. Station depth (m), water temperature ( $^{\circ}\text{C}$ ), and sediment type use patterns were examined using quotient analyses over the same time periods. All stages of yellowtail flounder exhibited northward shifts in distribution, declining in relative proportion on the mid-shelf of the Mid-Atlantic and Southern New England regions and increasing on Georges Bank and the western Gulf of Maine during recent years. Habitat use patterns have shifted slightly over the last four decades; depth, water temperature, and sediment type use has broadened in recent years. Results suggest that yellowtail flounder habitat use is flexible enough to adapt to changing environmental and anthropogenic effects.

**Factors Determining Accessory Growth Centre Formation and Otolith Growth during the Development of Otolith Microstructure In European Plaice, *Pleuronectes platessa* L.**

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Using otoliths for the back calculation of times of, e.g., hatching, metamorphosis, settlement etc, require an understanding of the meaning of ‘landmark structures’ in the otoliths and possibly the ability to count microstructure rings through these landmarks. Surprisingly enough, many of the landmarks on otoliths are assumed to indicate events in the life of a fish and back calculated ageing does not account for disruptions in the microincrement formation during these events.

The microstructure of plaice (*Pleuronectes platessa*) was investigated during metamorphosis with respect to larval age, size and development stage. Otoliths from laboratory reared plaice were marked by immersion of larvae in alizarin complexone to provide reference increments at known age. Sagittal otoliths were examined using transmitted and fluorescent light microscopy. No differences were found in growth and development rates between left and right otoliths from the same fish. The timing of metamorphic ring formation was determined by larval development stage with larval size being a possible contributing factor. Increment formation generally occurred on a less than daily basis. This was attributed to poor somatic and otolith growth. There was a good relationship between somatic growth and otolith growth once metamorphosis was complete. Otolith growth increased markedly around the time of metamorphosis. No obvious relationship was found in the total number of accessory growth centres that formed between different ages, sizes, and development stages of larvae.

**Assessing the Decline of Winter Flounder on Long Island:  
An Overview of SoMAS Research**

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In the southern New England/Mid-Atlantic region winter flounder has undergone a reduction in biomass declining to only 9% of target biomass levels. Antidotal data suggest even a greater reduction of winter flounder abundance in the bays of Long Island, New York, raising concerns that the species is heading for local extirpation. This presentation will review historical and contemporary causes of population decline examining overfishing, environmental change, and predation of young-of-the-year (YOY). Historical literature, long-term survey data and generalized additive models are utilized to explore the impacts of temperature and predation on YOY abundance. Results indicate overfishing has likely been a stressor during the last century and contemporary analysis suggests predation on YOY, particularly by species such as summer flounder and blue crab is a critical factor limiting recovery. Data analyses indicate that the decline of winter flounder on Long Island consisted of three phases: (1) an initial decrease in abundance during the 1990's; (2) a period of compensatory response during the late 1990's-mid 2000's, and (3) a complete recruitment failure beginning 2006-present. Evidence is provided suggesting survival post-settlement to end of the first summer is limiting successful recruitment; potential environmental and biological mechanisms are discussed.

## **Regional Differences in Mortality and Condition of Young-of-the-Year Winter Flounder in Long Island Bays**

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In recent years, populations of winter flounder (*Pseudopleuronectes americanus*) in Long Island have reached record low numbers, often hypothesized to be due to high rates of mortality in the first year of life. The aim of this two-year study is to investigate biological, environmental, and anthropogenic effects influencing the survival of young-of-the-year (YOY) winter flounder in Long Island bays. Samples were collected during bi-weekly beam trawl surveys from June to October 2010 in Jamaica Bay, Moriches Bay, Shinnecock Bay, Cold Spring Pond (Peconic Bay), and Napeague Harbor, and from May to October 2011 in Jamaica, Moriches, and Shinnecock Bays. These sites have varying degrees of anthropogenic impacts, declining from the west to eastern end of Long Island. Additionally, a caging study was added during 2011 in Jamaica, Moriches, and Shinnecock Bays to assess the impact of predation on mortality. Percent daily mortality ranged from 1.72-5.56 between the five sampling areas in 2010 and 2011. Long-term monitoring of environmental conditions in 2011 showed a strong connection between mortality and hypoxia in the field. Preliminary data on condition indices such as muscle RNA/DNA ratios, lipid content, Fulton's K, and hepatosomatic index (HSI) show declines in fall, suggesting poorer condition later in the season. Site-specific environmental and biological variables appear be correlated with health and survival indices. Once completed, this project will provide managers with information on which factors contribute most to YOY growth and survival of this important resource.

## **Extremely High Levels of Inbreeding in Winter Flounder from Southern Long Island Bays**

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Genetic diversity loss and inbreeding depression are typically secondary concerns when it comes to the management of marine fish, which are assumed to be buffered from these processes by relatively large population sizes and genetic connectivity over wide areas. We analyzed the genetic structure and diversity of an overexploited marine fish, the winter flounder, *Pseudopleuronectes americanus*, in 6 bays along the south shore of Long Island, New York using 11 microsatellite markers (6-56 alleles per locus). Although there was evidence of genetic connectivity between bays (global  $F_{st}=0.0105$ ), all loci were out of Hardy-Weinberg equilibrium due to excess homozygosity. This pattern is attributable to high levels of inbreeding (global  $F_{is}=0.2202$ ). Consanguineous mating appears to be very common in all locations, with the average internal relatedness (IR) of individuals being 0.226 (i.e., their parents were related at the half-sibling level on average). This study indicates that overfishing combined with larval retention and natal homing can lead to severe inbreeding in marine fish. The possibility that inbreeding depression is contributing to ongoing recruitment failure of winter flounder in this region should be further investigated.

## **Transcriptional Profiling of Young-of-the-Year Winter Flounder in Long Island Bays**

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Inshore winter flounder (*Pseudopleuronectes americanus*) populations have reached record low numbers in recent years, and recruitment into the fishery appears to be limited by survival of post-settlement juvenile populations. As part of a larger project examining factors influencing survival of young-of-the-year (YOY) winter flounder in Long Island bays, we are examining differential gene expression between populations in an attempt to identify metabolic and cellular pathways associated with site-specific variation in mortality and condition. Pooled cDNA libraries were created from livers obtained from YOY flounder collected at two sites (Shinnecock and Moriches Bays), and paired-end Illumina sequencing performed to identify differentially expressed genes between these populations. Over 180,000 contigs (>100 bp) were found with a mean size of 579 bp, and differential analysis was performed using DESeq. Reads were mapped back to the assembled transcripts using Tophat and counts coverage for each transcript. There were 253 differentially expressed transcripts (57% with functional annotation, all from teleost genomes), of which 180 and 73 were significantly over or under expressed, respectively, at Moriches as compared to Shinnecock. A high proportion of genes involved in wound healing and sugar/carbohydrate metabolism were observed in these differential groupings, and genes associated with stress response such as immune signaling, iron-binding-heme, and response detoxification pathways were also differentially expressed. Select genes from these groups are being further evaluated with qPCR for use as biomarkers of condition and response in individual fish across six different Long Island bays.

## **Alternative Overwintering Survival Strategy in Young-of-the-Year Winter Flounder**

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The first winter in the life of fish can be a period of high mortality prior to recruitment. When resources are limiting or fish are unable to feed due to low temperatures, starvation can often lead to size-dependent overwintering mortality. Larger individuals are typically better able to survive starvation because they have a higher percentage of energy reserves and a lower metabolic rate per-unit body mass. Many temperate zone species shift energy from growth to building lipid stores prior to the onset of winter. Alternatively, fish species that can feed during the winter are able to maintain their lipid stores, grow and reduce their chance of starvation. We examined the overwintering mortality, physiology and growth of young-of-the-year (YOY) winter flounder in relation to body size. Size-dependent mortality and growth were investigated with seventeen years of length-frequency data. In addition YOY winter flounder were sampled for diet and whole body crude lipid content over the course of a year and individual, temperature-dependent growth was investigated with an overwintering laboratory experiment. Samples were taken in three estuaries in the northeast US from October - April. Whole body crude lipid content ranged from 4.7% - 12.4% dry weight. Larger YOY winter flounder did not have higher lipid stores and the YOY fish did not exhibit size-dependent overwintering mortality. YOY winter flounder fed and grew throughout the course of the winter. Their diet consisted of amphipods and polychaetes and they maintained their whole body crude lipid content through the fall and winter. The physiology data lack temporal replication, however the spatial coherence among the three estuaries of two different stocks suggests that the consumption and energy allocation patterns are real and that YOY winter flounder follow an alternative overwintering survival strategy.

# Abstracts

## Poster Presentations

**Characterizing Winter Flounder  
(*Pseudopleuronectes americanus*) Nursery Areas  
Using Otolith Microstructure and Microchemical Techniques**

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The populations of winter flounder, a commercially important New England ground fish, are dramatically declining despite ever increasing fishing regulations. To combat this decline, it is imperative that the most productive habitats be identified, described, and protected. A preliminary study is being conducted to establish the effectiveness of using otolith microstructure and microchemical techniques for productive winter flounder nursery area identification.

Young-of-the-year winter flounder were collected from ten nursery areas from Connecticut to Maine. The sagittal otoliths were extracted from each sample; the left otolith was used for microstructure analysis and the right otolith for microchemical analysis.

Microstructure analysis, derived from otolith increment measurements, is being used to determine spatial variation in growth rates and early life history parameters between nursery grounds. Since growth rates have been directly linked to the survival of juvenile fish, identifying differences in the growth rates provides a way to rank the quality of each nursery area at a specific point in time. Understanding the timing of life history events in specific nursery areas also can be used to promote successful recruitment by indicating when and where habitat protection is most critical.

Spatial variation in otolith microchemistry is being examined using solution-based inductively coupled plasma mass spectrometry (SB-ICP-MS). Establishing natural tags through microchemical analysis of trace elements may be an effective method to assess stock structure, migration patterns, and connectivity between adult populations and nursery sources. Determining the scale at which the elemental signatures in winter flounder are site-specific creates an elemental signature index of nursery areas based on otolith composition. This index then may be used for stock identification and to trace adults back to natal nursery areas.

Information gained from this preliminary study has the potential to help develop models for critical winter flounder nursery characteristics that may be used in conservation policy.

# Historical Spatial Distribution of the Mid-Atlantic Winter Flounder Stock off of New Jersey Relative to Seasonal Spawning Movement

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The objectives of this study are to evaluate the decline in abundance and the distribution response of winter flounder, *Pseudopleuronectes americanus*, in New Jersey using historical trawl data sets. We are exploring the possibility that a historically recent change in migration biases assessment towards under counting fish in winter. We used historical data sets from the National Marine Fisheries Service, American Littoral Society, and the New Jersey Department of Environmental Protection for our study. Marker tags from the American Littoral Society recovered in New Jersey were all deployed in New Jersey. A single tagged fish moved south to North Carolina. The majority of the tags were deployed and recovered in the Hudson Bay with movement toward the Hudson River mouth. Time deployed ranged from days to years with an average of seven and a half months, thus many did not encompass a full annual cycle. Most winter flounder in trawl surveys were collected in northern New Jersey, inshore near Point Pleasant to Sandy Hook and offshore in the Hudson Shelf Valley. There was no significant difference in weight or length of winter flounder spatially, thus year-class contribution should not change distribution. We are focusing new tagging efforts (archival, acoustic, and marker) at the “Mud Hole”, a depositional feature near the head of the Hudson Shelf Valley, to explore the possibility of a non-migratory contingent cryptic to assessment.

## **Blue Crab Predation on Juvenile Winter Flounder Demonstrated by A New PCR Method**

**Jackie L. Collier, Sean Fitzgerald, Lyndie A. Hice, Mike G. Frisk,  
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Predation is thought to be the major cause of mortality in juvenile flatfish. Although direct visual inspection is effective in evaluating gut contents in vertebrate predators such as fish, trophic interactions involving crabs and other decapod crustaceans are difficult to reconstruct visually because crushing and maceration by the chelae and mouthparts during ingestion, combined with action of the gastric mill after ingestion, reduces soft parts of prey to unrecognizable mush. Molecular genetic methods are increasingly being applied to overcome these kinds of obstacles in gut content analysis. Of particular interest to the failure of recruitment to rebuild stocks of winter flounder in the Mid-Atlantic Bight and Southern New England region is the northward expansion of the range of blue crabs (*Callinectes sapidus*). To investigate whether or not blue crabs prey on juvenile winter flounder (*Pseudopleuronectes americanus*), we developed and validated a method to detect winter flounder DNA in the gut contents of blue crabs. A survey of 55 wild crabs collected from Shinnecock Bay, along the south shore of Long Island New York in July, August, and September of 2010, revealed that as many as 54% of the crabs sampled with material in their guts contained winter flounder DNA, demonstrating that predation by blue crabs could be an important source of mortality.

**Restoring Winter Flounder (*Pseudopleuronectes americanus*)  
Populations on Martha's Vineyard, Massachusetts  
Through Stock Enhancement**

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Winter flounder (*Pseudopleuronectes americanus*) spawning stock biomass is below critical levels and the Southern New England fishery is closed. There is little chance the stock can rebuild in the near future even with current regulations, making winter flounder a good candidate for stock enhancement. In order to determine if winter flounder stock enhancement is a viable management strategy, a pilot project was conducted on Martha's Vineyard, Massachusetts. This 2-year long project was a multi-town collaboration between local shellfish constables, commercial fishermen, the Wampanoag Tribe of Aquinnah, and the University of New Hampshire. Year 1 involved ecosystem analyses of two local estuaries (Lagoon and Menemsha Ponds) to determine appropriate stocking strategies and locations for juvenile winter flounder by examining the spatial and temporal abundance of the wild population, and their predators and prey. Year 2 consisted of converting an abandoned shellfish hatchery to include finfish production, and both raising and releasing juvenile winter flounder. Approximately 5000 winter flounder were released in August 2012 into Menemsha Pond. Stocking efforts continue to be measured through a post-release sampling program, and are presented in this poster.

## **Age, Settlement and Growth of Young of the Year Winter Flounder (*Pseudopleuronectes americanus*) in Long Island Bays**

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Winter flounder (*Pseudopleuronectes americanus*) are a historically important species targeted by commercial and recreational fisheries in Long Island which have significantly declined in abundance over the past two decades. These declines are suggested to be the result of inadequate recruitment of young-of-the-year (YOY) into older life stages. Although the causes of this bottleneck are poorly understood, it may relate to condition of the marine environment after settlement of YOY. This study utilized sagittal otoliths of YOY collected in bi-weekly beam trawl surveys from Shinnecock, Moriches, Jamaica and Hempstead Bays, Napeague Harbor and Cold Spring Pond in order to estimate date of settlement and measure relative growth rates within and among sites. Shinnecock, Moriches and Jamaica Bays were sampled in both 2010 and 2011; Cold Spring Pond and Napeague Harbor were sampled only in 2010, while Hempstead Bay was sampled only in 2011. Data pertinent to settlement and growth were compared with measures of environmental condition such as temperature and dissolved oxygen in each bay. Preliminary evidence suggests prolonged spawning seasons and extensive settlement periods at each site, with settlement periods typically spanning two to four months. This study will provide insight into how settlement distribution and relative growth rates are correlated with environmental parameters, mortality and recruitment of YOY. Information such as this can be utilized to implement more effective management strategies to help restore winter flounder in Long Island bays.

**Development of Models of European Plaice (*Pleuronectes platessa* L.)  
Population Dynamics Incorporating Biological Processes for Use in  
Risk Assessment of Management Options.  
II: Settlement and the Nursery Ground Phase in the Eastern Irish Sea**

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Juvenile flatfish, principally plaice, were sampled on their eastern Irish Sea nursery grounds in May and June during each year between 2000 and 2003. Sampling was undertaken using 1.5- or 2-m beam trawls towed orthogonal to the shoreline at low tide, covering a distance of 100m. Each haul was from offshore to inshore using All Terrain Vehicles (ATVs) to tow the trawls. Trawls were undertaken at 14 sites (converted to 7 zones) covering the eastern Irish Sea nurseries. All plaice were stored in liquid nitrogen for later analysis of the otoliths. Crabs were measured and released and the rest of the catch stored for subsequent analysis.

In plaice, the otoliths were extracted from a sub-sample and the number of primary increments counted for three regions of the otolith. The outer counts gave an indication of how long the fish had been on the nursery ground and the whole count an estimation of the hatch date. The shrimp (*Crangon crangon*), implicated along with the crabs as a principal predator of settling plaice, were counted and carapace length measured.

The major areas of settlement of juveniles are in Morecambe Bay (central eastern Irish Sea coast) and the beaches of the North Wales coast. There are also fairly large inter-annual differences in the densities of plaice and this is translated in to differences in the total population size. The two principal nursery areas for plaice are generally also the areas where the shrimp and crab densities are highest.

# **Advances in Tagging Technologies and their Applications in the Field**

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Advances in tagging technologies over the last two years have brought us back to the basics. The elusive question “*Where did my fish go?*” can now be asked and answered using new electronic tagging technologies. Light-based geolocation has been proven to be inadequate in determining location for several species of flatfish. The logic is simple; some fish spend significant amounts of time at depth away from light. With new technologies on the market, determining a fish’s location independent of light levels is now possible.

This presentation will review some of the uses of SeaTag devices on a variety of marine organisms from turtles, to sharks, and billfish. SeaTag devices use a 3-axis magnetometer to analyze Earth’s magnetic field which is then converted to latitude estimation. By using a magnetometer, tags are no longer subject to the requirements of light-only tags. This technology does have its limitations. Even SeaTag devices cannot determine longitude without available light levels, but latitude can be estimated even in its absence. Location accuracy will be demonstrated through several case studies.

# **Larval Development and Salinity Tolerance of Japanese Flounder (*Paralichthys olivaceus*) from Hatching to Juvenile Settlement**

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Salinity tolerance and growth of Japanese flounder *Paralichthys olivaceus*, at different developmental stages were evaluated, including newly hatched larvae, yolk sac larvae, oil droplet larvae, post oil droplet larvae, premetamorphic larvae and prometamorphic larvae, at eleven salinities from 5 to 55 ppt for 96 hours. The ontogenesis during the early life of *P. olivaceus* was investigated under hatchery salinity 35 ppt. The results showed that suitable salinity for newly hatched larvae, yolk sac larvae, oil droplet larvae, post oil droplet larvae, premetamorphic larvae and prometamorphic larvae ranged from 10 to 25 ppt, 10 to 30 ppt, 20 to 30 ppt, 30 ppt, 10 to 30 ppt, 15 ppt, respectively, demonstrating an ontogenetic variation of salinity tolerance. The salinity tolerance of newly hatched larvae, yolk sac larvae, and premetamorphic larvae was stronger than that of oil droplet larvae, post oil droplet larvae and prometamorphic larvae. The yolk sac larvae and premetamorphic larvae displayed wide salinity tolerances. The present findings demonstrate that the suitable salinity for larviculture of *P. olivaceus* is 20–25 ppt before the depletion of oil droplet; after that, higher salinity (30 ppt) should be ensured for the post-oil droplet larvae; the premetamorphic larvae can be cultured at a wide salinity range (10–30 ppt), and the metamorphosed larvae should be reared at salinity about 15 ppt.

## **Bilateral Modeling of Jaw Force and Skull Kinetics In the Gulf Flounder, *Paralichthys albigutta***

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Migration of the eye during development contributes to bilateral asymmetry in flatfishes. Functional consequences of this morphological asymmetry were examined in the gulf flounder, *Paralichthys albigutta*. Seven gulf flounder were collected from the Florida coast (Atlantic and Gulf of Mexico) by hook and line or seine net in 2001-2002. Fish were preserved in 10% formalin for approximately one week and later transferred to 70% ethyl alcohol. To model the feeding biomechanics, gulf flounder were dissected to reveal the jaws and muscles of the head. Important biomechanical landmarks of the ocular and blind sides were digitally photographed and measured using image analysis software. Measurements included opening and closing in-levers, the lower jaw out-lever, adductor mandibulae II muscle length, and mandible length. The adductor mandibulae muscle was subsequently extracted, divided into the three principle divisions ( $I\alpha$ ,  $I\beta$ , and II) and weighed. These measurements were entered into the biomechanical modeling software MandibLever to generate predicted torque, gape velocity, and angle velocity. The modeling results were used to compare jaw force and skull kinetics of ocular and blind sides. For six of the flounder, most modeled variables were not significantly different between sides. One exception was effective mechanical advantage, which indicated the blind side consistently demonstrates greater mechanical advantage. Additionally, one small flounder (13 cm SL versus an average of 22 cm SL) exhibited asymmetry across a number of variables. As a result, future work will increase the sample size of smaller flounder to examine ontogenetic changes in feeding performance.

# Temporal Influences on Abundance and Size Distributions of Flatfishes in a Shallow Estuarine Creek in Georgia

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Temperature and seasonal change may play crucial roles in the selection of nursery habitats by flatfishes. The purpose of the present study was to investigate the patterns in use of a shallow estuarine creek by flatfishes to determine the effect of seasonality on species composition and abundance over a long-term period. Monthly samples were collected during ebbing tide between January 2004 and October 2012 in Wylly Creek (31°59'52"N, 81°03'18"W), in Savannah, Georgia. Tows were conducted for 2 minutes at idle speed using a 1-m wide beam trawl with a 3-mm mesh net. Means were calculated from the number of individuals per sample date by season. Six species were collected throughout the study: the blackcheek tonguefish, *Symphurus plagiusa*, the bay whiff, *Citharichthys spilopterus*, the fringed flounder, *Etropus crossotus*, the summer flounder, *Paralichthys dentatus*, the southern flounder, *Paralichthys lethostigma*, and the ocellated flounder, *Ancylopsetta quadrocellata*. The most abundant species throughout the study was the blackcheek tonguefish, *Symphurus plagiusa* ( $7.15 \pm 0.90$ ), with peak abundance during summer ( $12.75 \pm 2.72$ ). The bay whiff, *Citharichthys spilopterus* were most abundant during winter ( $14.05 \pm 5.58$ ) when mean size was the shortest ( $16.8 \pm 0.4$  mm) and least abundant during fall ( $0.82 \pm 0.46$ ) when mean size was the longest ( $81.9 \pm 5.3$  mm). The major finding of this study was that bay whiff used Wylly Creek as a nursery in early winter, while the other species utilized this creek during later juvenile stages.

# Elucidating the Taxonomic Status of Tonguefishes Presently Identified as *Symphurus microrhynchus*: Discovery of a Species Complex

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*Symphurus* Rafinesque contains about 79 valid species distributed primarily in tropical and temperate waters worldwide. Most Indo-West Pacific members of *Symphurus* are deep-sea species, usually inhabiting waters between 200 and 1500 m depth. Of these, only *S. microrhynchus* and *S. monostigmus* are recorded shallower than 200 m. *Symphurus microrhynchus* is presently considered to be a widely-distributed species in the Indo-West Pacific, though specimens from throughout this range exhibit morphological variation. Specimens from several geographic regions that we tentatively identified as *S. microrhynchus* (N= 104) reveal persistent morphological variation indicating that a complex of species, rather than one widespread species, is represented by this material. One or two cryptic species of this species complex were discovered in each region examined. Molecular methods examining sequence distances between specimens from Taiwan and Viet Nam, regions where tissue samples were collected, also indicated a species complex among tonguefishes currently identified as *S. microrhynchus*. Sequence distances between Taiwan and Viet Nam species, for example, were 8.66% K2P divergence in COI gene and 3.86% K2P divergence in 16S rRNA. These sequence distances are greater than expected between conspecific allopatric populations indicating that subtle morphological variations observed between geographic populations actually reflect differences among several species. Based on morphological characters, we diagnose seven nominal species representing three phenetic groups as members of the *S. microrhynchus* species complex. Molecular analyses provided independent assessments for evaluating the significance of subtle morphological variation between species, and sequence data were especially helpful in discovering cryptic species within this species complex.

## **Interannual Variation in Size Distribution of the Benthic Flatfish, *Pseudopleuronectes americanus*, in Clinton Harbor**

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Winter Flounder (*Pseudopleuronectes americanus*) are commonly found within Clinton Harbor, Connecticut, located within the estuarine environment of Long Island Sound (LIS). *P. Americanus* are commonly found in and adjacent to Cedar Island Marina (CIM) which indicates this area as a nursery habitat for young-of-the-year. Eight sites (four within CIM and four adjacent to CIM) were trawled using a 1-m beam trawl throughout 2010 and 2011 to analyze size distribution by year, month, and site. All *P. americanus* caught were weighed, measured and found to be young-of-the-year, ranging from 16-mm to 294-mm in length and from 0.1g to 57.22 g in weight. In both 2010 and 2011, young-of-the-year were largest during the fall months ( $p < 0.001$ ). The average length and growth rate of *P. americanus* was significantly higher during 2010 ( $p = 0.001$ ). This may have resulted from the large number of harsh winter storms, which allowed for ideal temperature and salinity. These factors compounded with a higher level of dissolved oxygen allowed for increased prey abundance, which may have caused the increased growth during 2010.

# **Parametric Model Selection of Fish Age and Size at Maturity: An Application with Different Stocks of Winter Flounder**

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Fitting maturity data to a binomial model is a common and useful practice in fishery science. Maturity is typically viewed as a two-step process – a fish is either immature or mature – so a binomial model is inherently appropriate. However, several binomial link functions with different cumulative density functions are available: probit, logit, Cauchit, complementary log-log, and log. I empirically investigated whether any of these functions consistently provides less uncertainty using an information-theoretic approach (i.e., the Akaike Information Criterion). Maturity of female winter flounder (*Pseudopleuronectes americanus*) was evaluated using gonad histology, and ages were determined by counting annuli on scales or otoliths. To capture spatial variation, the data were grouped into five regions extending from the northern Gulf of Maine to Georges Bank to offshore of New Jersey. In preliminary analyses, the probit and logit functions performed consistently well. The Cauchit and complementary log-log functions occasionally provided the lowest uncertainty, and may be suitable in specific cases. The log function did not fit the winter flounder maturity data, but this function may be suitable for species exhibiting rapid maturation.

**Development of Models of European Plaice (*Pleuronectes platessa* L.)  
Population Dynamics Incorporating Biological Processes for  
Use in Risk Assessment of Management Options  
I: The Egg and Larval Phase in the Eastern Irish Sea**

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The abundance and distribution of plaice eggs and larvae were studied in the eastern Irish Sea between February and May 2000 to 2003. Ichthyoplankton were sampled with a Gulf VII high-speed plankton sampler from approximately 48 stations. Complementary physical data were also collected at each station. In all cases, plaice eggs were identified and staged. Using stage-related development rates, the abundances were converted to stage I egg production and the spawning curve was estimated from General Additive Modeling (GAM) for each year.

In the eastern Irish Sea, there are essentially two spawning concentrations, one in the southern Irish Sea and the other in the north. Generally, the southern site produces higher concentrations of stage 1 plaice eggs. There were inter-annual differences in the annual plaice egg production and the peak spawning period appeared to shift by plus or minus two weeks.

The plaice egg distributions were incorporated into Irish Sea hydrographic 3-D and particle tracking models. Here the eggs were passive drifters and the larvae undertook vertical migrations. The aim was to test the hypothesis that individual larval behavior is important for transport from the spawning to nursery grounds. The results clearly show that tidally-synchronized vertical movement is required to move larvae into the settlement areas identified from the beach sampling program. In addition to information on plaice, the ichthyoplankton surveys also gave spatial and temporal information on other flatfish species in the eastern Irish Sea.

# **Site Dependence or Density Dependence: Using Geospatial Analysis to Test Models of Habitat Use and Inform Conservation and Management**

## **I. Yellowtail Flounder (*Limanda ferruginea*) on Georges Bank**

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Three theories of habitat use proposed for marine fishes-- the Constant Density Model, the Proportional Density Model, and the Basin Model-- make contrasting predictions of how the geographical range, local density, and fitness change as population size changes. We tested model predictions with survey data on yellowtail flounder from the Georges Bank region, where abundance changed by a factor of 4 over a decade. Surveys took place in spring and fall, and data on individual length, mass, sex and reproductive status were available. Analysis of spatial pattern revealed that the overall area occupied by flounder increased by a factor of 2 when abundance was high, and local density increased predominantly in high-quality habitat that had been closed to commercial fishing. Condition, which served as a proxy for fitness, was lower in females when abundance was high. Geospatial analysis revealed mesoscale variability in condition, over tens to more than a hundred km, except in the spring season during low abundance periods. Spatial autocorrelation explained as much as 25% of the variability in condition, indicating that site dependence was a factor in explaining the spatial distribution that we observed. These results are most supportive of both the Constant Density Model and the Basin Model. This approach detected an important population center for yellowtail flounder and determined its extent using only measures of abundance, location, and condition of individual fish, data commonly collected during routine fishery assessment surveys. Here we demonstrate that analyses linking population responses to variation in such measures at local spatial scales can have significant implications for identifying areas of important fish habitat and suggest greater use of geospatial approaches in conservation and management of exploited species.

## **Spermatogenesis, Reproductive Maturation, and Spawning Seasonality of Male Winter Flounder, *Pseudopleuronectes americanus***

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Spermatogenesis, reproductive maturation, and spawning seasonality of male winter flounder, *Pseudopleuronectes americanus*, were compared among portions of three US stock areas: Gulf of Maine (GOM), Georges Bank (GB), and Southern New England (SNE). Fish were obtained on a monthly basis (December 2009– May 2011) and additional samples (May 2012) from commercial fishing vessels participating in cooperative research programs; and supplemental samples were acquired from fisheries-independent research surveys. Using histology, six stages of spermatogenesis were observed, namely, in order of development: primary and secondary spermatogonia, primary and secondary spermatocytes, spermatids, and spermatozoa. The seminiferous development was highly homogeneous within the testes of all individuals. The gonadosomatic index (GSI) began increasing in October; by early winter mature males contained spermatozoa and GSI reached its peak values. However, spawning activity peaked at different months for each stock: SNE peaked the earliest, in March; followed by GB, in April; and finally GOM, in April and May. Overall, GOM displayed a lower peak GSI compared to GB and SNE. Histological criteria were applied to define one immature (I) class and five mature classes: developing (D), ripe (R), ripe and running (U), spent (S), and resting (T). Using this I-D-R-U-S-T scheme, maturity ogives were generated. The two inshore stocks (GOM and SNE) had similar maturity ogives, but maturity occurred at a larger size in the offshore stock (GB).

**Detecting an Environmental Gradient in Maturity of Winter Flounder  
(*Pseudopleuronectes americanus*) Stocks:  
Does Thermal Habitat Create Spatial Heterogeneity of Life History  
Parameters within Stock Boundaries?**

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Regional variation in life history parameter estimates of marine teleost species is frequently used to discriminate stocks spatially. While such differences are often tied to environmental effects, observed variation has been traditionally discussed in relation to time (*i.e.*, length-at-age and age-at-maturity estimates). The growing degree day (GDD, °C·day), an index of thermal energy quantifying the heat available for growth, provides a physiological time scale that more logically relates an organism's growth to its environment than time. Reported variation in growth and maturation among and within the three US winter flounder stocks indicates that temperature is likely one of the key factors driving observed differences; trends generally follow a south-to-north pattern mirroring environmental temperature gradients. Bottom temperature data were used in conjunction with age estimates to calculate GDD values for winter flounder sampled throughout the species' US range. Given its broad latitudinal distribution, the species encounters both low and high temperature stress; therefore, GDD was modeled as a nonlinear function of temperature. Resulting GDD values were used to examine the variation in length-at-age and maturity in US waters that can be attributed to temperature.

## **Burying Ability of Cage-conditioned Japanese Flounder Reared For Stock Enhancement**

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Burying ability is essential for flatfish to be both stealthy predators as well as cryptic prey; however, fish reared for stock enhancement may take days to weeks to refine burying skills once released. Implementing conditioning strategies before release can improve the ability of flatfish to bury in sediments. Our objective was to assess whether cage-conditioning juvenile Japanese flounder, *Paralichthys olivaceus*, in the shallow coast can enhance burying ability. We examined burying via video-based experimental trials conducted in the laboratory immediately following the cage-conditioning experience. We compared the performance and behavior of four fish types: (1) “conditioned” fish which spent 7 d in a predator-free conditioning cage, (2) “non-conditioned” fish directly from tanks, (3) “wild” fish, and (4) non-conditioned fish that were “released then recaptured” after 6 d at large in the wild. We evaluated the degree of concealment (0, 25, 50, 75, or 100%) of individuals by examining still video frames at 30 min intervals during the first 24 hr after cage retrieval. Burying was significantly highest for wild fish, followed by conditioned fish, and then non-conditioned and released-then-recaptured fish, which were not significantly different from each other ( $P < 0.0001$ ). Fish tended to bury less (i.e., remain exposed more) as the day progressed (mid-day to nighttime), while the opposite trend was observed the following morning: fish buried least in early hours and progressively buried more as the day progressed (morning to mid-day). This study provides evidence that cage-conditioning can enhance burying ability of released flatfish.

## **Long-term Data Sets on Fishery Resource Occupation of NY/NJ Harbor: What Have We Learned and Where Do We Go From Here?**

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The US Army Corps of Engineers, in partnership with the Port Authority of New York and New Jersey, is nearing completion of the congressionally authorized Harbor Deepening Project (HDP). The scale of the HDP required extensive interagency coordination to ensure that environmental impacts were minimized. Prior to construction, knowledge gaps in the biological resources of the Harbor were identified and long-term sampling programs were established to evaluate the relative importance of aquatic habitats within the harbor, including the re-configured navigation channels. The Aquatic Biological Survey (ABS) was developed to assess the seasonal distribution and abundance of aquatic species with a focus on winter flounder, a species of prioritized concern. Initiated in 1998, the ABS has sought to characterize essential fish habitat (EFH) for various life history stages of targeted species by means of systematic ichthyoplankton and trawling surveys. Developing an understanding of when and where winter flounder eggs and larvae are present within the HDP area and how their presence is related to environmental factors greatly improves the ability to effectively manage dredging activities in the Harbor. Areas within the Harbor have been demonstrated to have differential use as spawning habitat. In addition, winter flounder use of navigation channels is now sufficiently well known to provide insights into effective dredging project management practices. The benefits of the investment in long-term studies will be a vital factor in sustaining winter flounder and other EFH resources within the harbor as dredging requirements transition from deepening to maintenance of the navigation infrastructure.

## **Feeding Kinematics of the Winter Flounder, *Pseudopleuronectes americanus***

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Flatfishes exhibit a range of morphological asymmetry from nearly symmetrical to highly asymmetrical. The functional and ecological consequences of morphological asymmetry have only been examined for a few, moderately asymmetrical species. To better understand the ecomorphology of flatfishes, the feeding kinematics of the winter flounder, *Pseudopleuronectes americanus*, was examined. Aquariums were constructed with a one centimeter grid on the back and elevated to permit a mirror for viewing the blind side. Winter flounder were fed two centimeter pieces of a *Nereis* p. worm. Feeding was recorded at 120 fps using a Photron PCI Fastcam high-speed motion video camera. Motion analysis software was used to examine videos and measure five variables: mouth gape, head rotation, head depth, head tilt, and head width. Mouth gape, head rotation, and head depth were all measured from the blind side, while head tilt (deflection of the head to the blind side) and head width were measured from a ventral view. While there was significant individual variation in the timing of movements, the general pattern of movements was relatively consistent. There was clear evidence of functional asymmetry during feeding events as exhibited by measures of head tilt which ranged from 5.53° to 22.05°. Overall, winter flounder kinematics exhibited similarities to previously studied flatfishes, but also demonstrated enough differences to indicate that more research on flatfish feeding kinematics is needed.

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